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OF
THE SECRETARY OF COMMERCE
FOR THE FISCAL YEAR ENDED JUNE 30, 1930

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EIGHTEENTH ANNUAL REPORT

OF THE

SECRETARY OF COMMERCE

1930

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EIGHTEENTH ANNUAL REPORT

OF THE

SECRETARY OF COMMERCE

DEPARTMENT OF COMMERCE,
OFFICE OF THE SECRETARY,
Washington, November 4, 1930.

To the PRESIDENT:

I have the honor to submit herewith the Eighteenth Annual Report of the Secretary of Commerce in the following parts:

Economic Review.
Elimination of Waste.
Progress in Development of Civil Aeronautics.
Condensed Reports of Bureaus.

The Director of the Bureau of Foreign and Domestic Commerce in his report has discussed in detail our foreign trade for the past year and for that reason a separate review of that subject has not been submitted.

As the Fifteenth Decennial Census was taken as of April 1, 1930, the Director of the Bureau of the Census has embodied in his report detailed information concerning that enumeration as well as the several other censuses taken at the same time. Therefore, special attention is invited to the report of that bureau.

The report has been prepared for transmission to Congress as required by the organic act of the department.

Very sincerely,

R. P. LAMONT,
Secretary of Commerce.

ECONOMIC REVIEW

Notwithstanding the decided decline in business activity which began in November, 1929, the total output of commodities and services in the fiscal year ended June 30, 1930, was very large. Comparison of the conditions during the year with those of the year immediately preceding, which had been a period of exceptionally high activity, gives a misleading impression. Most of the business indicators for 1929–30 compare favorably with any earlier year.

The most comprehensive measure of the volume of industrial production is the general index of output of manufactured and mineral commodities compiled by the Federal Reserve Board. This index for the fiscal year just closed averaged 110 as compared with the average for the three calendar years 1923–1925 taken as 100. It was about 6 per cent lower than in the fiscal year 1928–29, but slightly higher than in any of the three years, 1925–26 to 1927–28, and decidedly higher than in any still earlier year.

The closing months of the fiscal year 1928–29 had witnessed unprecedented activity in our factories and mines. The index of industrial production for June, 1929, stood 25 per cent above the average for 1923–1925. Activity continued high for the first few months of the last fiscal year; it fell rather sharply in November and December, remained more or less stationary from January to May, and again fell decidedly in June. As a consequence the index for June, 1930, was about 20 per cent lower than in June, 1929.

Major economic indexes

[Based on calendar years 1923–1925=100]

Year ended June 30 and month	Volume of output					Value of sales	
	Manufacturing production	Minerals production	Railroads, ton-miles revenue freight	Electric power production	Building contracts let in 37 States	Department stores	Mail-order houses
1920	90	82	96	----------	90	88	106
1921	72	83	90	70	46	92	75
1922	75	69	79	72	74	85	64
1923	98	93	96	88	91	94	82
1924	97	101	97	95	93	99	92
1925	99	98	98	102	95	100	103
1926	107	99	105	116	122	104	118
1927	108	114	111	129	108	106	120
1928	106	103	104	138	116	107	131
1929	117	111	110	154	112	109	166
1930	110	110	104	163	81	108	186
June, 1928	[1] 111	[1] 101	100	140	142	104	137
June, 1929	[1] 129	[1] 113	109	155	110	106	176
June, 1930	[1] 101	[1] 100	92	155	73	95	166

[1] Adjusted for seasonal variations and for differences in the number of working days in the month.

The indexes for production of manufactured goods show substantially the same movement as the general index of industrial production, as might be expected from the fact that manufactured goods

dominate in this general index. The separate index for mineral production for 1929–30 showed much less change from the preceding year, and there was also much less change during the course of the year itself. By reason of the continued large production of coal and petroleum, which are the major factors in the general index for minerals, the combined index for the fiscal year as a whole was only 1 per cent lower than for the preceding fiscal year and about 3½ per cent below the peak figure of 1926–27. Mineral output in June, 1930, was about 11½ per cent lower than in the corresponding month of the previous year. There had, however, been marked reductions in output of copper and zinc.

The following table shows the relative output (in terms of quantity, not value) of a number of major manufactured and mineral commodities for the fiscal year 1929–30 as compared with the two preceding fiscal years. In a majority of cases the production last year was less than the year before, although there were several exceptions. On the other hand, more than two-thirds of the items listed show greater production than in 1927–28:

Production indexes

Product	Year ended June 30, 1929–30, compared with—		Product	Year ended June 30, 1929–30, compared with—	
	1927–28	1928–29		1927–28	1928–29
Flour	103.0	100.4	Coke	112.0	99.9
Pork products (including lard)	97.3	100.1	Copper (smelter)	105.0	86.2
Beef	94.0	100.7	Zinc	96.3	94.8
Cotton goods (mill consumption of cotton)	90.2	90.0	Pig iron	109.9	95.0
			Steel ingots	110.5	90.7
			Cement (Portland)	98.3	98.3
Wool goods (mill consumption of wool)	96.1	90.9	Crude petroleum	109.6	103.1
Silk (deliveries of raw silk to mills)	103.9	100.3	Gasoline	130.9	110.4
Paper-board boxes	122.1	105.0	Rubber tires (casings)	90.2	72.7
Newsprint (consumption)	112.8	107.1	Plate glass (polished)	119.2	100.4
Boxboard	107.7	98.2	Automobiles	123.3	80.9
Shoes	100.1	99.7	Foundry equipment (new orders)	132.9	94.6
Cigarettes	119.2	105.2	Machine tools (new orders)	114.7	70.2
Coal (bituminous)	105.4	97.5	Electric current	118.1	105.6

The traffic of railroads was naturally affected by the decline in the production of commodities, but the ton-mileage carried by the railways in the fiscal year 1930 has been surpassed in only three other years. Traffic in June, 1930, was about one-seventh less than in the same month of 1929.

The industry most affected by the recession of business was that of construction, which had already begun to decline during the fiscal year 1928–29. The value of construction contracts let during the year ended June, 1930, was less than in any other fiscal year since 1921–22, and over 14 per cent less than in the preceding fiscal year.

The production of electric power in the United States normally shows a rapid increase; the increase in the fiscal year 1929–30 was less than usual, and there was no substantial change in output between June, 1929, and the corresponding month of the year just closed.

One of the noteworthy features of the year's business was the continued demand for consumers' goods, reflected in the fact that the value of department-store sales, notwithstanding somewhat lower prices of commodities, was only very slightly less than the peak figure of 1928–29, while the mail-order houses and 5-and-10-cent-store chains continued to increase their sales, largely as a result of the establishment of new department stores by the mail-order concerns and of the increase in the number of stores in the chains. These indicators, however, show declines in June, 1930, as compared with the preceding June.

The somewhat reduced activity of manufacturing and mining industry during the fiscal year just closed was accompanied by a smaller employment of labor and an increase in part-time work. The average number of wage earners employed in factories during 1929–30, according to the index of the Department of Labor, was 3.7 per cent less than in the preceding year, and the amount on the pay roll fell somewhat more, or by 5.3 per cent, the difference in these two percentages being due, not to lower rates of wages, but to greater prevalence of part-time operations. The number of workers on the pay rolls at the close of the fiscal year was about 13 per cent less than in June, 1929, while the amount of the pay roll had declined about 7 per cent. It is a noteworthy fact that practically no cuts in wages have been made by employers as a result of the recession of business. This stands in marked contrast with the practice in previous similar recessions. It marks the widespread conviction that permanent progress in prosperity is dependent on liberal wages and consequent large buying power on the part of the masses of the people, and that recovery from any temporary setback will be promoted by the same policy.

The fundamental cause of the rise in the standards of living, which has characterized every decade of our national existence, is the advance in efficiency of production. The output per man has greatly increased by reason of greater skill and intelligence on the part of the workers, improvement in methods of organization and management, progress in science and invention, and greatly increased use of capital as an aid to human labor. In the report of this department for 1927–28 statistics were given showing the relative number of workers and relative quantity of goods and services produced in the four branches of manufactures, agriculture, mining, and railway transportation. These showed marked gains in productivity per person employed for recent years as compared not merely with the beginning of the century but with the year 1919. For the 30-year period these gains ranged from about 57 to 115 per cent in the different branches, and since 1919 they ranged from 10 to 40 per cent. Still further advance has been made since 1927.

This progress in production per man during recent years is conclusive evidence that the advance in economic activity has not been wholly or even chiefly a mere upswing in the business cycle to be followed by an equally great downward movement. It has marked a permanent achievement, and when the present recession is over the same upward movement will unquestionably be resumed. The causes at work are for the most part of a cumulative character, so that it may be said that each forward step leads to another step in the same direction.

PRICES

The steadiness of price levels which had characterized most recent years was broken by a very considerable decline during the last fiscal year. For the year as a whole the wholesale price index of the Department of Labor (converted to the base 1923–1925 as 100) averaged 91.9 as compared with 96.7 during 1928–29, a decline of about 5 per cent. For the group of farm products the decline was slightly greater, while the two groups of foods and commodities, other than farm products and foods, averaged about 3 per cent below the preceding year.

The decline in wholesale prices set in during October, 1929, the index for September being only insignificantly lower than the peak for July. Between September and June, 1930, the general index fell almost 11 per cent, and the decline continued in July, although no further drop occurred in August or September. The reduction in prices was much less precipitous than that which occurred in 1921. Indeed, although it took place during a shorter period of time, the total amount of the drop was but little greater than that which occurred between March, 1923, and June, 1924.

The decline in prices was shared by all three of the great groups of commodities but was especially marked in farm products. The index for this group fell about 17 per cent between September and June and fell 6½ per cent further in July, though it has since shown some recovery. The index for all commodities except farm and food products, consisting chiefly of manufactured goods and minerals, had remained substantially unchanged from April, 1927, to October, 1929. From October, 1929, until June, 1930, it fell about 7½ per cent. All of the 8 classes of nonagricultural commodities set forth in the statistics of the Department of Labor have declined in price; the change has been particularly conspicuous in the textile, metal, and miscellaneous classes, the last mentioned being largely dominated by rubber which has shown a very rapid drop in price.

The decline in prices in the United States is part of a world-wide movement. The price indexes of several of the leading foreign countries have shown even a greater fall. As is normally the case, the reduction in prices in this and other countries, has been more conspicuous in raw materials than in manufactured goods. This is the natural result of the fact that wages constitute a larger proportion of the cost of advanced commodities than of those of simpler form and that wages seldom fall as rapidly as prices; in fact, in the United States they have practically not fallen at all during recent months.

Retail prices normally show less variability than wholesale prices, partly because they are more fixed by custom and partly for the same reason that manufactured goods show less variability than raw commodities. For the fiscal year 1929–30, as a whole, the cost of living index compiled by the National Industrial Conference Board averaged slightly lower than for the preceding fiscal year. The index scarcely began to fall before December and the total decline between November and June was about 5 per cent.

Wholesale and other prices index, fiscal years 1922–1930

[Based on calendar years 1923-1925=100]

Item	1922	1923	1924	1925	1926	1927	1928	1929	1930	June, 1929	June, 1930
Wholesale prices:											
General average	92.2	100.5	97.4	99.8	101.8	96.1	95.8	96.7	91.9	95.7	86.2
Farm products	88.1	94.1	95.3	103.7	103.3	93.7	101.9	102.2	97.2	100.5	86.5
Foods	91.8	96.8	95.8	101.3	107.3	103.0	104.3	106.0	103.2	104.5	95.7
Other products	96.7	104.5	98.9	98.0	99.6	94.5	90.8	91.0	88.2	90.9	83.7
Hides and leather products	100.5	103.8	97.2	101.0	98.3	97.5	114.6	109.9	102.5	104.1	98.7
Textile products	88.1	99.2	99.7	98.6	96.5	88.1	88.9	88.0	82.0	85.8	75.6
Fuel and lighting	99.2	115.8	96.8	97.1	102.7	99.8	86.5	87.0	83.7	87.4	80.2
Metals and metal products	99.6	100.1	101.5	98.3	94.4	93.6	92.2	96.9	95.2	98.9	89.7
Building materials	88.7	102.6	100.9	97.3	96.7	93.6	88.3	92.4	91.6	92.5	86.4
Chemicals and drugs	104.8	100.5	98.6	99.7	100.8	97.6	95.4	94.6	91.0	92.8	88.4
House furnishing goods	99.2	101.2	101.5	98.6	96.2	93.4	93.1	91.6	90.9	91.5	91.1
Miscellaneous	95.7	96.7	94.6	95.6	111.6	91.4	86.7	79.4	78.7	79.8	73.9
Farm prices	86.0	93.0	95.0	102.0	103.0	93.0	99.0	98.0	96.0	97.0	89.0
Retail foods	97.5	95.4	97.8	100.1	108.0	105.0	102.6	103.3	103.8	103.3	98.7
Cost of living:											
December	101.1	98.3	100.5	100.1	103.2	101.9	99.8	99.4	99.4	------	------
June	96.5	98.4	98.1	100.6	101.4	100.6	98.6	98.7	97.0	------	------

AGRICULTURE

The crops harvested in 1929, the most basic factor in the agricultural situation for the fiscal year 1929–30, were of approximately average magnitude, the general index of quantity produced being about 4 per cent below the peak figures of 1928. The prices at the time of harvest were about at the average point of recent years, and to the extent that farmers marketed their crops shortly after harvest, their income was approximately normal. Prices of farm products declined materially later in the fiscal year, as already pointed out.

The Department of Agriculture calculates the aggregate value of farm products on a calendar-year basis. According to these calculations the gross income of the farmers from crops and animal products in 1929, excluding duplication due to the feeding of crops to animals, was nearly $12,000,000,000, slightly less than in 1925 but somewhat greater than in most other recent years and about 1.1 per cent larger than in 1928. As compared with 1928 there was a decrease in the value of crops, but an increase in that of animal products, the latter figure being greater than in any other year covered by the tabulations. It is estimated that the cash income from farm sales amounted to $10,147,000,000 in 1929 which was slightly higher than the income in 1928 and also somewhat above the average of the past five years.

Estimated farm value of products, gross income and cash income, calendar years 1924–1929

[Value in millions of dollars]

Item	1924	1925	1926	1927	1928	1929
Crops:						
Farm value	10,537	10,008	9,285	10,078	9,806	9,498
Gross income	6,240	6,225	5,540	5,902	5,737	5,681
Cash income	5,570	5,505	4,870	5,270	5,091	5,007
Animal products:						
Farm value	5,086	5,820	6,078	5,978	6,205	6,426
Gross income	5,166	5,819	6,010	5,797	6,061	6,243
Cash income	4,137	4,655	4,856	4,683	4,965	5,140
Grand total (excluding duplications):						
Gross income	11,406	12,043	11,550	11,699	11,798	11,924
Cash income	9,707	10,160	9,726	9,954	10,056	10,147

The 1929 output of corn, wheat, oats, rye, potatoes, and barley was somewhat below the average of other recent years. That of tobacco and hay was well above the average. Cotton production was larger than in any other year except 1925 and 1926.

A severe drought occurred during the summer months of 1930, extending over a large area. It was most severe in a belt running from the Atlantic coast to the Missouri River and extending some distance north and south of the Potomac and Ohio Rivers. There was relatively little injury in the grain-producing States of the Northwest, while in the mid-West the yield of corn was cut below the average. The drought had little effect on the production of wheat. Although the country's feed crops are considered sufficient, a large amount must be shipped into deficit areas. The President's drought conference is coordinating the efforts of various agencies in the alleviation of the abnormal conditions caused by the drought.

The results of the elaborate census of agriculture, taken in April, 1930, are of course not yet available. The only item thus far reported is that of the number of farms, which was 2.3 per cent less than in 1920. It is probable that there has been an even greater decrease in the number of persons living on farms and the number engaged in agricultural occupations. The increase in the efficiency of agriculture, which has been continuous throughout the history of the country, but perhaps especially marked since the close of the World War, has made it possible to supply the needs of a growing population without increasing the number working on the land. A constantly larger proportion of the people have thus been able to devote their efforts to producing more highly elaborated commodities and services characteristic of advanced standards of living. Farm products are for the most part necessities of life, and it is natural that the demand for necessities should expand little, if any, more rapidly than the number of inhabitants of the country. On the other hand, the demand for many classes of manufactured commodities is almost unlimited, and new and more highly elaborated articles of manufacture are constantly being introduced so that the total consumption of factory products increases, with the growth of efficiency in production, much faster than the population.

CONSTRUCTION

Although, as already stated, construction considered as a whole was much less active in 1929–30 than in most recent years, the activity of public-works construction and public utilities was the greatest ever recorded except during the World War.

The total value of reported contracts for all types of construction in 36 States (the far-western States are not covered by the returns) for the fiscal year was 14 per cent less than in 1928–29, while the floor space decreased 28 per cent. On the other hand, the value of contracts for public works and utilities was 11 per cent greater than the year before.

The most marked decline was in residential building, which had already shown some decrease during the preceding fiscal year; the value of residential contracts let in the 36 States during 1929–30 was 40 per cent less than in the preceding year, while the amount of floor space decreased 43 per cent. During the summer and early autumn

of 1929 the strong demand for capital for stock-market speculation made it difficult to obtain credit for home building on reasonable terms. After the November drop in the stock market credit became easier, but meantime the demand for new houses has been reduced by the unfavorable business situation.

The most recent surveys of vacancies in the various cities have indicated that the number of unoccupied dwellings is not excessive and that, owing to the curtailed amount of new building, the unoccupied space is being diminished. With the abundance of funds seeking investment and the recent decreases in the prices of building materials, it appears that a definite revival in residential construction should not be far distant.

The extraordinary volume of construction projects for public works and utilities during the fiscal year, as a whole, was due almost wholly to the record made during the first six months of 1930, when special efforts were being put forth by the Federal, State, and local governments, and by the privately owned utilities to carry out large programs as a part of the general stabilization program. The authorities concerned were able to take advantage of low rates of interest for obtaining necessary loans, and of the lower construction costs that have prevailed.

The large volume of construction in public works and public utilities resulted in the cement shipments being practically as great as they were in the preceding fiscal year.

For the first time since 1923, movements in building material prices and building costs have been of sufficient magnitude to warrant special mention. After the temporary peak in prices in the spring of 1923 the tendency was, on the whole, slightly down until late in 1927, when there was an upturn lasting until 1929. Wholesale prices of building materials dropped 10 per cent in the first eight months of 1930 which was much larger than in the most recent years.

The cost of buildings and other construction work has also been lessened during recent years as the result of various technical improvements in construction methods and machinery. The reduced cost of building due to these factors is sometimes overlooked in comparing the prices of houses and other buildings, because of the tendency to incorporate in the buildings a higher quality of finish and more elaborate equipment.

Construction contracts awarded in 36 States, fiscal years 1928–1930

[Source: F. W. Dodge Corporation]

Class	Value (millions of dollars)			Floor space (millions of square feet)		
	1928	1929	1930	1928	1929	1930
Total	6,329	5,990	5,148	[1] 877	[1] 847	[1] 608
Residential	2,712	2,281	1,365	536	468	268
Public works and public utilities	1,256	1,250	1,387			
Industrial and commercial	1,394	1,571	1,492	212	257	215
All other	967	888	903	130	122	124

[1] Floor space of public works and public utilities not included.

Construction statistics, fiscal years 1922–1930

[Based on calendar years 1923–1925=100]

Item	1922	1923	1924	1925	1926	1927	1928	1929	1930
Indexes of volume of business:									
Construction contracts awarded—									
Value, including public works and public utilities [1]	[2]	[2]	88	101	129	130	133	126	109
Floor space of buildings [1]	[2]	[2]	92	95	122	107	116	112	81
Residential construction—									
Value [1]	[2]	[2]	75	82	109	98	105	88	53
Floor space [1]	[2]	[2]	79	78	104	87	99	86	50
Public works and public utilities, value [1]	[2]	[2]	73	89	103	128	138	137	152
All other construction—									
Value [1]	[2]	[2]	72	85	110	113	106	111	108
Floor space [1]	[2]	[2]	75	80	98	94	94	104	93
Cement shipments	71	90	93	105	108	113	116	118	116
Price indexes:									
Frame-house materials, retail	[2]	99	103	98	97	95	90	88	88
Building-material prices, wholesale	89	103	101	97	97	94	88	92	92

[1] 36 States. [2] Comparable data not available.

TRANSPORTATION

The net operating income of Class I railways (which represents about 98 per cent of the total railway business) during the fiscal year ended June 30, 1930, was less than in the previous year, but was greater than in 1927–28. The volume of freight traffic handled (ton-miles of revenue freight) from July to December, 1929, practically equaled the figures for the corresponding period of 1928. For the entire fiscal year the revenue ton-mileage was about 5 per cent less than in 1928–29, but about 1 per cent greater than in 1927–28.

Reflecting continued increased efficiency the traffic of 1929–30 was handled with fewer employees, fewer freight cars, and fewer locomotives than in any other year of similar volume of business. The use of larger cars and more powerful locomotives, permitting the handling of heavier trains, has tended gradually to raise the average amount of freight carried per person employed on the railroads. In the last fiscal year the average weight of revenue ton freight hauled per train was 799 tons, fractionally less than in 1928–29, but comparing with 776 tons in 1927–28 and 656 in 1921–22. The new cars and locomotives that are being added from time to time are of much larger capacity than those installed 20 or 30 years ago or even 10 years ago.

Although the proportion of total revenue from passenger service has been decreasing for some time, the railways are continually adding improvements in the way of added facilities and comfort to the traveling public. Economies in the conduct of passenger service have also been introduced without lowering the quality of the service.

In fact, the quality of service furnished by the railways, as well as other public carriers, has continued to improve and is now better than at any other time in the history of the country. Car shortages have become rare occurrences. At present it takes only from one-half to two-thirds as long to move goods a given distance as it did a decade ago. The increasing efficiency with which traffic is handled has enabled producers to make quicker deliveries and distributors

are able to carry smaller stocks and to turn over their capital more quickly.

The national forecasts of the Regional Advisory Boards have served admirably in indicating business trends and have proved of great value to industry in determining future activities.

The railroads have performed useful service in relieving drought conditions during the past summer by issuing low-rate tariffs for animal feed and livestock moving in and out of the drought-stricken areas, and for rail carriage of water where needed.

Operating statistics of Class I railways fiscal years 1922–1930

[Source: Interstate Commerce Commission and Bureau of Railway Economics]

Item	1922	1925	1926	1927	1928	1929	1930
Freight ton-mileage (millions):							
Revenue	313,439	396,621	427,385	449,285	420,312	447,024	423,067
Nonrevenue	38,097	40,766	43,398	46,192	44,330	44,763	42,643
Tons of revenue freight originated (thousands)	940,056	1,210,118	1,273,048	1,351,076	1,246,228	1,320,086	1,280,828
Cars loaded (thousands)	40,658	49,678	51,905	53,627	50,576	52,716	50,394
Net tons per train, average	656	731	752	786	776	803	799
Net tons per loaded car, average	26.8	27.0	27.0	27.6	26.7	26.8	26.9
Average daily car surplus	272,756	252,410	218,779	213,154	303,408	232,378	326,719
Average daily car shortage	2,410	295	435	287	133	57	44
Bad-order cars, average number	339,369	194,519	172,252	144,668	141,508	142,672	141,796
Bad-order locomotives, average number [1]	15,764	11,514	10,478	9,302	8,880	8,343	8,103
Employees, average number	1,643,000	1,765,000	1,782,733	1,798,495	1,711,200	1,679,553	1,639,881
Total operating revenues (thousands of dollars)	5,508,169	6,011,864	6,325,158	6,442,387	6,096,483	6,334,043	5,976,001
Net operating income (thousands of dollars)	818,345	1,033,766	1,194,832	1,209,535	1,074,341	1,294,470	1,088,473

[1] Includes switching and terminal engines.

The merchant marine act of 1928, providing for enlarged loan funds and overseas mail contracts, has resulted in a steady advance of our merchant marine. Shipbuilding has substantially increased and privately owned merchant marine is being developed, while the Government is steadily retiring from the business. All important trade routes from the United States to other parts of the world are now being served with American owned and operated ships—25 private companies now operate 79 lines, 44 from the Atlantic seaboard, 14 from the Gulf, and 21 from the Pacific coast. The amount of tonnage under construction on July 1, 1930, increased 187 per cent over that on July 1, 1929.

During the past year considerable progress has been made in the development of inland waterways. A notable event occurred after the close of the fiscal year when the Seventy-first Congress, on July 3, 1930, passed the largest and most comprehensive rivers and harbors bill in the history of waterway legislation. This act provides for a total of 178 new projects and the preliminary examination and survey of 389 other projects at an estimated cost of $400,000,000. Improvements in all sections of the country are provided for and substantial progress is being made on the projects now under way.

BANKING AND FINANCE

Financial conditions in the United States were dominated by the security market. The fiscal year opened with stock quotations still

rising rapidly, after years of an almost uninterrupted "bull market." The total market value of all stocks listed on the New York Stock Exchange increased from $77,265,000,000 in July to $89,670,000,000 in September—a 16 per cent appreciation in two months. The collapse of stock prices in October and November, however, brought the market value of these listed stocks down to $63,590,000,000 as of December 1, a drop of almost 30 per cent. An average of 30 leading industrial stocks showed a decline of about 48 per cent between September 3 and November 13. Only the action of a hurriedly organized banking syndicate and the admirable preparedness of the Federal reserve banks prevented a still more serious collapse of our security market.

A marked advance in stock quotations occurred during the first quarter of the calendar year 1930. Approximately half of the 1929 decline was made up, and the industrial averages were almost as high as in the corresponding period of 1929. This rally, however, was followed by a second decline, the value of all listed stocks falling from $76,075,000,000 at the end of March to $63,890,000,000 at the close of the fiscal year, or not very much above the level for the end of November.

The collapse of the security market was followed by an almost complete cessation in new financing; issues brought out during November totaled only $280,000,000 as against the all-time record of $1,300,000,000 in September. When activity in the flotation of new securities was renewed during the first quarter of 1930, corporations seeking new capital turned to bond issues in view of the unpopularity of new stock issues and the improvement in bond prices. New bond issues floated during that quarter totaled $1,867,000,000, a figure more than a half billion higher than in the corresponding period of 1929. Stock issues during this same three months' period aggregated only $110,000,000.

The fiscal year closed with the rediscount rate of the Federal Reserve Bank of New York down to 2½ per cent, the lowest rate ever established by a Federal reserve bank. Rates on call loans and renewals were down to 1½ per cent; while 90-day bankers' acceptances were bid at 1⅞ per cent, the lowest since 1924. These low money rates resulted from security liquidation, slackened business activity, and heavy gold imports, as well as from the cheap-money policy of the reserve banks. In accordance with that policy these banks bought securities, thereby releasing credit funds to the banks. Government securities held by those institutions, amounting to only $147,000,000 in July, 1929, were increased to $446,000,000 by December and had reached $590,000,000 on June 30, 1930.

A factor that is generally regarded to have had a most disturbing effect upon the money market was the volume of nonbanking funds placed in brokers' loans. It was these funds that created the dangerous expansion of brokers' loans during the early part of the past fiscal year, and their sudden withdrawal aggravated the credit difficulties following the stock-market crash. During the fiscal year call loans decreased from $7,071,000,000 to $3,728,000,000, or by over $3,343,000,000, a large part of which shrinkage resulted from the withdrawal of nonbanking funds.

The trend of commercial banking is indicated in a combined statement of the "reporting" member banks of the Federal reserve system as of June 18, 1930.

Between June 19, 1929, and June 19, 1930, loans secured by stocks and bonds show an increase of $1,233,000,000, or 16.7 per cent. As nonsecured loans (mainly commercial) decreased $648,000,000 or 7 per cent, during the same period, total loans recorded an expansion of $585,000,000, or 3.5 per cent. There was a small increase in investments, bringing total "loans and investments" up to $23,118,000,000, as compared with $22,298,000,000 as of the same date in 1929. During the same period demand deposits increased by $698,000,000 and time deposits by $504,000,000.

In addition to investment-trust issues it is reported that the increase in "loans on securities" also represents loans to insurance companies necessitated by the increased demand for policy loans. A substantial part of these loans may have also been on large volumes of securities, which were being held by various financial institutions for higher market values. The liquidation of loans other than those secured by stocks and bonds represents both a retirement of commercial loans contracted last fall to carry securities during the market crash, and a shifting from direct to indirect borrowing in order to take advantage of exceptionally low open-market rates.

The trend toward chain and group banking, banking consolidations, and the expansion of branch banking was again evident during the past fiscal year. The merging of important banking institutions in our larger cities has resulted in a marked reduction in the number of banks as well as a large-scale concentration of banking resources. As a result of one of these mergers, the largest bank in the world is now domiciled in the United States.

The broad demand for prime short-term investments, together with low rates, has greatly increased the use of the banker's acceptance as a means of financing. Outstanding acceptances at the close of the fiscal year were $192,000,000 greater than a year ago, a marked contrast to the large decline in direct borrowings from banks for commercial purposes during the same period. Most of the increase was represented by the $178,000,000 growth in "foreign" acceptances, a measurement of the greater use of American credits to finance the storage of goods abroad or their shipment between foreign points. Because of the decrease of our foreign trade during the fiscal year, there was a shrinkage in acceptances based on imports and exports. The $1,305,000,000 of acceptances outstanding as of June 30, 1930, however, was the highest ever recorded at the close of a fiscal year.

Foreign securities publicly offered in the United States during the first three months of the past fiscal year amounted to only $79,655,000 (net nominal), the lowest total for any corresponding quarter in six years. This decline is ascribed to the diversion of investment funds into security speculation and to the resultant rise of money rates both here and abroad. During the last three months of 1929 the $133,540,000 of foreign financing indicated a gradual return to the volume of recent years; and this trend became even more pronounced during the first six months of 1930, when foreign capital issues underwritten here exceeded the total for the entire

calendar year 1929 by almost $100,000,000. The sudden decline in our capital exports during the first half of the fiscal year is commonly blamed for part of the recent sharp decline in American exports and for part of the business recession in foreign countries.

The inflow of gold which had been uninterrupted during the speculative boom was abruptly halted during November and December, at which time there was a net outflow of about $110,000,000. The movement of gold, however, has been decidedly in our favor during the first half of 1930—net gold imports during that period totaling approximately $213,000,000. The greater part of this increase in our gold stock took place during February, March, and April, over $60,000,000 coming in during each of these three months.

Despite the enormous acceleration of the number of check payments in the autumn of 1929, during the increased liquidation of security holdings, the total value of bank debits recorded a decrease of 2½ per cent from the preceding year, declining from the record high of $865,000,000,000 for the year 1928–29 down to $843,000,000,000 for the total of the past fiscal year. This was the first decline in the total value of all check payments for a great many years. Some part of this decrease compared with the preceding fiscal year was undoubtedly caused by the relatively inactive state of business during the period following the stock market crash.

The United States Government again maintained its rapid retirement of the public debt. The interest-bearing public debt was brought down to $15,866,000,000 on June 30, 1930, a reduction of about $738,000,000 during the year. This compares with the debt reduction of $679,000,000 during 1928–29. The excess of ordinary receipts over total expenditures chargeable against ordinary receipts was $183,789,000 for the fiscal year 1929–30, about the same surplus as was recorded during 1928–29.

FOREIGN TRADE

The recession in general business activity which has appeared in the United States during the last fiscal year has been world-wide; indeed, in several important foreign countries recession had begun even earlier than in the United States. The reduced buying power of the world naturally resulted in a decline in the exports of the United States as it did also in the exports of practically every other important country. Correspondingly, the reduced buying power in the United States itself cut down our imports from the rest of the world during the last half of the fiscal year, 1929–30. The decline in the value of our exports and imports was greater than that in the quantitative volume as the result of the lower prices of commodities, particularly conspicuous in the import trade.

The total value of exports (including reexports of imported goods) in the fiscal year 1929–30 was $4,684,000,000. This was $678,000,000, or 12.6 per cent below the record figure of 1928–29. It was, however, only 5.5 per cent less than the average value of exports for the 5-year period from 1924–25 to 1928–29, and when account is taken of the lower price levels the exports were quantitatively somewhat greater than the average of that 5-year period.

Foreign trade of the United States

[Millions of dollars]

Item	Year ended June 30—						Per cent change in 1930 from—	
	1910–1914	1922	1927	1928	1929	1930	1928	1929
Exports of United States merchandise	2,130	3,700	4,867	4,773	5,284	4,618	−3.3	−12.6
Exports, including reexports	2,166	3,771	4,968	4,877	5,374	4,694	−3.8	−12.6
Imports, merchandise	1,689	2,608	4,252	4,147	4,292	3,849	−7.2	−10.3
Excess of exports (+) or imports (−):								
Merchandise	+477	+1,163	+716	+730	+1,082	+845		
Gold	+17	−441	−148	+498	−155	−223		
Silver	+20	−8	+21	+20	+17	+18		
Quantitative index eliminating the effect of price variations (1910–1914=100):								
Exports of United States merchandise	100	117	175	174	193	173	−.6	−10.4
Imports	100	134	180	184	202½	200	+8.7	−1.2

The value of imports decreased somewhat less than that of exports; they amounted to $3,849,000,000 as compared with $4,292,000,000 in 1928–29, a decline of 10.3 per cent. The decline as compared with the average for the fiscal years 1924–25 to 1928–29 was 8.3 per cent. It is estimated that the average price level of imported commodities during the fiscal year was about 9 per cent lower than in the preceding year, and no less than 18 per cent lower than in the preceding 5-year period. There was, therefore, relatively little decline in the quantity of imports as compared with 1928–29, and a considerable increase as compared with the average for the 5-year period.

The reduction in exports was shared by all four of the major economic classes, foodstuffs, crude materials, semimanufactures, and finished manufactures, but was relatively greatest in foodstuffs and crude materials, and least in finished manufactures. As a consequence, the share of finished manufactures in the total of our exports, which has risen almost constantly throughout the recent decades and recent individual years, rose still further in 1929–30, reaching very nearly half (49.6 per cent). Finished manufactures are less subject to variations in demand and especially less subject to variations in price than the less advanced products and are consequently a stabilizing factor in our export trade.

There was also a decline as compared with 1928–29 in the imports of each of the four major economic classes. The most marked reduction, in terms of value, was in the class of crude materials, a fact chiefly, if not wholly, attributable to the decided drop in the prices of many of the leading commodities of this group. Just as with exports, the imports of finished manufactures, although falling off in absolute value, showed a relative gain, amounting to 23.8 per cent of the total imports in value as against 22.4 per cent in the preceding year.

Although cotton continued to be our largest single export in value during 1929–30, machinery was a close second. The quantity of cotton exported fell materially and its value still more, whereas the value of machinery sold abroad reached a record total, notwithstanding the depressed business situation in foreign countries. There

was also an increase in the exports of petroleum and its products. The reduced buying power of the world was, however, reflected in a reduction of more than one-third in value of exports of motor vehicles, which fell from second to fourth rank among our export commodities. Among the major import articles the most conspicuous declines in value appeared in coffee, rubber, and sugar, all of which fell materially in price, while in the case of rubber and sugar there was also a reduction in the quantity imported.

Trade with all the great trade areas of the world in both directions was smaller in value last year than the year before. In exports, reductions were particularly conspicuous in the case of South America, northern North America, Asia, and Oceania, and less pronounced in the case of Europe, Latin North America, and Africa. There was less difference among the continents with respect to the percentage of decline in value of imports. The most marked reduction was in our purchases from Asia, which fell about 10 per cent in value, chiefly by reason of lower prices of the major commodities brought from that continent.

Foreign trade of the United States

[Millions of dollars]

	Year ended June 30—						Per cent change in 1930 from—	
	1910–1914 average	1922	1927	1928	1929	1930	1928	1929
TOTAL EXPORTS, INCLUDING REEXPORTS OF FOREIGN MERCHANDISE								
To—								
Europe	1,350	2,068	2,394	2,322	2,397	2,173	−6.4	−9.3
All other continents	816	1,703	2,575	2,555	2,977	2,521	−1.3	−15.3
Canada and Newfoundland	320	551	797	871	999	830	−4.7	−16.9
Latin America	302	536	869	831	970	848	+2.2	−12.5
Asia	121	480	587	568	686	566	−.4	−17.4
Oceania	48	84	216	174	193	160	−7.7	−16.9
Africa	25	52	106	111	129	116	+5.0	−9.9
EXPORTS OF UNITED STATES MERCHANDISE								
Foodstuffs	421	1,144	877	824	806	658	−20.1	−18.4
Raw materials	713	933	1,321	1,174	1,239	1,031	−12.2	−16.8
Semimanufactures	342	412	694	714	730	637	−10.8	−12.8
Finished manufactures	654	1,211	1,976	2,062	2,508	2,293	+11.2	−8.6
GENERAL IMPORTS								
From—								
Europe	836	831	1,257	1,258	1,302	1,188	−5.6	−8.8
All other continents	853	1,777	2,995	2,889	2,989	2,661	−7.9	−11.0
Canada and Newfoundland	119	310	486	492	516	488	−1.0	−5.6
Latin America	435	679	1,049	1,039	1,089	949	−8.6	−12.8
Asia	259	705	1,315	1,215	1,223	1,097	−9.7	−10.3
Oceania	17	31	59	54	57	40	−25.4	−29.8
Africa	23	52	86	90	104	88	−2.2	−15.6
Foodstuffs	398	635	968	969	971	837	−13.6	−13.8
Raw materials	595	927	1,651	1,541	1,510	1,309	−15.0	−13.3
Semimanufactures	307	407	759	746	849	785	+5.2	−7.6
Finished manufactures	389	639	874	892	961	918	+3.0	−4.5

ELIMINATION OF WASTE

Many of the activities of the agencies functioning under the auspices and authority of the Department of Commerce are of importance in the general campaign aimed at the elimination of unnecessary waste. Prominent among these activities from the point of view of waste elimination are those relating to the production, distribution, and utilization of manufactured commodities, and to the operation and control of equipment involving hazards to life and property.

Mechanical equipment which is capable of functioning but which remains idle, and laborers willing to work but remaining unemployed, represent definite economic loss. In the elimination of waste of this kind the Department of Commerce has been especially active.

CONSTRUCTION AND HOME OWNERSHIP

The Government's program of cooperation with public and private agencies in regard to outstanding problems of the construction industry and home ownership has been signalized by two outstanding developments, both closely associated with the department.

The first of these was the movement to hasten certain types of construction, notably new public works and utilities projects, and repairs and maintenance to existing buildings of all types. This was part of the general program to help sustain business and employment after the collapse in security prices in the autumn of 1929.

The second was the initiation, announced shortly after the close of the fiscal year, of the President's Conference on Home Building and Home Ownership. This conference is to be held after several months of preparation, during which committees will be engaged in studying and reporting on the many different problems involved. In addition to these and other activities which are discussed in this section, the construction industry has been aided by the department's work on standardization and simplification of building materials, improved wood utilization, and scientific investigations of the manufacture, uses, and properties of building materials which are described elsewhere in this report.

Planning and control of public works.—Reference was made in last year's report to the study of the planning and control of public works undertaken by this department in cooperation with the National Bureau of Economic Research and the Committee on Recent Economic Changes of the President's Conference on Unemployment. The fact-finding survey, which was completed last autumn, developed certain conclusions which were used when the President's stabilization program was initiated. It was clearly brought out that, although the usual course at such times had been for local governments to follow a policy of retrenchment, there is a growing recognition of the numerous and obvious advantages (from the standpoint of busi-

ness stability) in having public-works construction proceed more actively during periods when general business and employment are slack.

The President's appeal to governors and to State and local officials under them for the "energetic, yet prudent" pursuit of needed public-works projects was highly successful, as is mentioned in the Economic Review. In order to aid in coordinating the work of the Federal Government bureaus carrying on construction and the efforts of State and local governments, the division of public construction was established, and immediately availed itself of the preparatory work and experience which had been accumulated in the department.

On the basis of data obtained from the governors in regard to public works and from the national business survey conference in regard to public utilities, it was learned that more than $7,000,000,000 worth of new construction, including some other capital expenditures for improved plant and equipment, together with certain items of maintenance and repairs, would be undertaken during the year. Latest indications are that this program is being carried through. During the first six months of 1930 it appears that at least $1,700,000,000 worth of work was undertaken or executed by public authorities and a like amount by the utilities, a sum $400,000,000 in excess of that during the corresponding period in 1929. The Class I railroads alone report having spent $118,000,000 more for additions and betterments during the first half of 1930 than in the same period of 1929.

The success attending this effort to support the economic structure at a period of crisis, when failure would have plunged the Nation into a much more serious situation, is an encouraging step in the general program for greater stabilization of business and of employment and should lend strength to the department's continued efforts, through the development of improved statistics and other means, to place construction on a more stable basis, both seasonally and from year to year. In this connection the department is encouraging the compilation of adequate periodic local real-estate and building-vacancy surveys, a movement which has gained considerable strength during the past year or two.

Home building and home ownership.—The department's activities designed to promote home ownership on a sound economic basis have been guided during the past fiscal year with special reference to laying a groundwork for the President's Conference on Home Building and Home Ownership. This conference was formally set in motion shortly after the close of the fiscal year through the appointment by the President of a planning committee with the Secretary of Commerce as chairman.

The expenses of organizing the conference are being met from funds which have been privately contributed, and many private organizations, including trade associations, professional societies, and civic bodies, have offered their cooperation in carrying out studies of important problems.

Much material in the Bureau of Standards, especially in its division of building and housing, and in other bureaus of the Commerce and other Federal departments will be of particular assistance to the various committees in getting under way promptly. In

preparing a pamphlet, Care and Repair of the House, which has been completed, a considerable mass of material relating to the various parts of the house and its fundamental equipment, such as heating, lighting, plumbing, and refrigeration, was consulted, analyzed, and listed in convenient form for future reference in connection with other phases of home building. This particular pamphlet is designed to aid home owners in keeping their houses in good repair and in an attractive condition. At the same time, it should help them to reduce their repair bills, which amount to several hundred million dollars a year.

Again, the elements of small-house construction, as they affected present building practices, and standards recommended for various parts of the house by different agencies were all surveyed in some detail in connection with writing up the results of a field survey of small-house construction. A considerable amount of material has also been assembled on one of the central problems of the conference—home financing. Financing above the limits of the customary first mortgage—a field in which bonuses, fees, commissions, and extra charges are the rule—is believed by many competent authorities to present one of the greatest opportunities for direct savings to the home buyer or home owner. Furthermore, serious fluctuations in the supply of credit available to home owners contribute to instability in real estate, and in business and employment generally. Satisfactory solution of these matters should contribute to greater stability in home property values, and go a long way toward enabling families to own their homes on a sound basis.

Uniformity of local building codes.—Each year brings a new list of municipalities which, because of growth in population or other causes, find it advisable to adopt formal building regulations. In addition, numerous cities and towns decide to overhaul their existing regulations so that they may conform more closely to advances in engineering knowledge and to modern conceptions of what constitutes proper provision for health and general welfare. To such places the recommended minimum requirements of the department's building-code committee, composed of nationally known architects and engineers, offer a source of information that can be used with confidence. That this is appreciated is attested by the hundreds of applications for the recommendations and for related data. During the past year, contacts with building officials and code-revision committees have been made closer, in part as a result of field work, and this has permitted orienting the department's activity so as to facilitate its most effective application.

Planning and zoning.—There continues to be a growing demand for the department's services on the part of municipalities and other political units actually concerned in planning and zoning problems. The extension of interest in regional planning has been a particularly notable development in recent years. There are now more than 50 official and unofficial regional planning commissions or organizations throughout the country, representing a population of more than 39,000,000 and a land area of 96,000 square miles.

Zoning ordinances have been adopted by more than 900 cities, towns, and villages, and included in that number are 61 cities having more than 100,000 population each. Zoning enabling legislation has

been adopted by 46 States and the District of Columbia. A Standard State Zoning Enabling Act, prepared by the Advisory Committee on City Planning and Zoning in 1923, has been used by the legislatures of 35 States in the enactment of 54 zoning laws. There is a trend now toward extending zoning beyond the limits of municipalities into outlying rural areas, and regional, county, and township zoning laws are being adopted.

The department's Standard City Planning Enabling Act, published in 1927, by the adoption of which States may confer adequate city-planning powers on municipalities, and which also contains regional planning provisions, has served as the basis for 11 acts in eight States. The effect of the development of city planning and zoning has been far-reaching and undoubtedly has resulted in a reduction of the huge wastes which not infrequently have been caused in the past by the improper location of buildings and public improvements.

DOMESTIC MARKETING SERVICES

The Bureau of Foreign and Domestic Commerce has achieved distinct success during this past year in its work of isolating and treating those individual sources of marketing waste which in the aggregate are costing the country perhaps $10,000,000,000 annually. These wastes arise from a multitude of causes, but it has been found possible to locate many of them specifically and, in cooperation with industry, to work out formulæ for their reduction on a practical scale.

Among these causes are excessive expenditures in sales-promotive effort without adequate information as to prospects; haphazard procedure in retail merchandising arising out of extravagant services, unwise credit methods, and insufficient attention to cost records; indifferent or total absence of stock control; insufficient data as to national stocks of goods and the channels through which they move; and disorderly marketing, with resulting gluts and famines.

Known causes of wastes in marketing by no means constitute all costly leaks which exist in our distributive system; but as a recognized result of these wastes, there is too great a difference between the price paid to the producer and the cost to the ultimate consumer, and too many distributors who either fail in business or operate on a dangerously narrow margin. The operations of the domestic commerce division to eliminate waste have a double function: To find causes of waste and to assist American business in removing them as they are found.

Practically every American industry in every section of the country is now calling on the Bureau of Foreign and Domestic Commerce for assistance with those problems which influence the economic distribution of commodities. Out of this voluntary relationship there has developed a cooperative program embracing, among others, the following practical features:

Cost studies.—Far-reaching benefits resulting from the department's analyses of distribution costs have already been reported by distributors who have applied these findings to their own establishments. The investigations into wholesale and retail distribution

have actively gone forward for several lines of trade, including groceries, hardware, dry goods, paints and varnishes, electrical equipment, and specialties. Out of these studies has crystallized a definite method of functional cost allocation, which may easily be adopted by any member of the trade in determining the profitableness of his own individual commodities, customers, or services. In all of these investigations the examples of economies, actually effected through practical application of the principles so disclosed, have had a salutary influence throughout that whole trade. The lessons have been convincing because in every case they have been supported by facts.

An outstanding effort toward the elimination of waste in distribution is the Louisville grocery survey, which is still under way and is being reported in a series of preliminary releases described in another section of this publication. This survey is regarded as the most comprehensive fact-finding investigation that has ever been undertaken with regard to the distribution of commodities. The Louisville grocery survey has led to a broad movement for trade betterment through waste-eliminating operations that has acquired nation-wide proportions. The Louisville Board of Trade has stated that the grocery survey had a minimum value of $100,000 to the city of Louisville alone. The really significant thing about this $100,000, however, is that the results of this special research which produced it can be applied just as directly to distribution problems in other cities and in other trades.

Retail credit survey.—An annual waste of nearly $1,000,000,000 is said to be attributable to credit losses. Last year's report described the domestic commerce division's effort to reduce this loss through a survey of retail credit practices, in cooperation with the National Retail Credit Association. The results of this survey, published in three sections, have recently been made available to the public, and from retailers in various sections of the country statements are already being received which indicate a tendency toward greater care in investigating applicants for credit. Because of its obvious practical uses, and at the instance of the national association, it is now being continued on a semiannual basis.

Industrial surveys.—The results of preliminary studies of the effects of age and condition of productive equipment on profits reveal both a clear need for extension of these types of industrial surveys to every trade where the problem is important, and their value in the general program of waste elimination. There has been a brisk demand for copies of such reports as have been published, covering investigations of the equipment used in the blue-print and allied industries, iron foundries, and knitting plants.

Regional commercial surveys.—The domestic regional division provides two types of badly needed background data. The first type involves the measurement of potential consumptive capacity of existing marketing areas within the United States. The effort here is to show the territory which may be served economically from established distributing points without regard to geographical State boundaries, and to show, for each such territory, the pertinent indexes of buying power and consuming ability. The Market Data Handbook, which the bureau was able to compile, fills a long-felt want in making possible the more scientific and practical adjustment

of selling and advertising campaigns to logical, really profitable sales territories and classes of consumers.

Three editions of this handbook have been exhausted in a single year, and there are now more than 8,000 copies in use.

The second type of regional study undertakes to ascertain and diagnose limiting factors in given regions which may be obstructing economic progress. For example, the tendency toward migration of the textile industry from New England produced a vital local need for a definite determination of desirable industrial readjustments, opportunity for development of substitute enterprises, etc. For another example, the shifts in agricultural production in the South brought about by the ravages of crop diseases and the rapid industrialization of many sections have completely changed the basic economic structure of that entire region. In both these cases the bureau's regional-survey staff has been able to compile the pertinent facts most helpful toward practical solutions of these important regional problems.

SIMPLIFIED PRACTICE

As business becomes more and more complex, individual plants and factories expand to meet added demands upon their facilities. Competition urges the production and handling of an increased number of different commodities, and stampedes each commodity into taking on new shapes, sizes, and immaterial variations. The problems of all departments become burdensome until the point is reached where sales analyses are mandatory for the good of all. Such surveys unmistakably reveal those varieties of product which bring in a profit and those which are losing propositions. Net profits depend upon rapidity of turnover and frequency of reinvested capital. "Frozen capital"—money that is tied up in slow-moving stock—is to be avoided. There are individual manufacturers and distributors that have eliminated considerably more than three-fourths of their varieties without anything but good resulting from their action.

During the past nine years the division of simplified practice, serving as a coordinating agency for manufacturers, distributors, and consumers seeking to minimize the waste resulting from excessive diversity in sizes, dimensions, and immaterial differences of commodities, has aided the affected industries in the promulgation of 113 simplified-practice recommendations; 15 of these were completed during this past fiscal year.

This record shows that industries have manifested a growing desire to work with each other in solving problems of mutual interest. Also, it shows that distinct industries are finding it increasingly practicable to work together toward the common end of eliminating avoidable waste. It has been found that such cooperation is particularly significant because the producers in one industry are consumers of the products of other industries. Such collaboration should aid in promoting stability in the production and exchange of goods.

Sustained interest in the simplification movement is indicated by the high average adherence accorded recommendations now in effect. Eighty-four per cent of the output of commodities covered by the

29 simplified practice recommendations that were reviewed this fiscal year, as revealed by statistical reports from the participating manufacturers, conformed to the recommended sizes, dimensions, and varieties.

The average of the yearly adherence figures for the last nine years is very nearly 84 per cent.

Simplification is being applied in the solution of problems of distributors as well as those of production. A field study of wrapping and purchasing methods involving 34 department stores in 17 cities is now being made. It is estimated that the present cost of handling and distributing packages in the stores of the country is about $90,000,000 annually, so that a small percentage in saving would represent a large amount in money.

CERTIFICATION AND LABELING

In cooperation with governmental specifications-using agencies (Federal, State, county, and municipal), with other consumers and with producers and distributors, the Federal specifications and approved commercial standards have been brought to the attention of the interested producers and a large number of users of commodities covered by these specifications and standards, through the medium of the certification plan and the accompanying self-identifying quality guaranteeing labeling plan.

To assist in broadening the field of supply of commodities purchased under Federal specifications and expanding the mass production, mass distribution, and mass consumption of these commodities, the National Bureau of Standards has compiled complete lists of manufacturers desirous of accepting contracts based on certain of these specifications and willing to certify to purchasers, upon request, that the commodities delivered under these contracts comply with the requirements and tests of the specifications. Lists of "willing-to-certify" manufacturers corresponding to 281 Federal specifications and commercial standards have already been compiled. More than 9,000 requests for listing have been received from about 3,000 manufacturing firms.

At the suggestion of the Chief Coordinator these lists have been distributed to the purchasing agencies of all Federal Government departments and establishments. They have also been distributed to about 25,000 additional public purchasers for all of the States, counties, and cities throughout the country, all municipalities having the commission form of government, and to more than 500 purchasers for colleges.

In accordance with the self-identifying, quality guaranteeing labeling plan, a firm desiring to bring effectively to the attention of the noncontract or "over-the-counter" buyer, at the time of making a purchase, commodities guaranteed to comply with the requirements of certain nationally recognized specifications places on the individual commodities or their containers labels which definitely identify both the specification and manufacturer or the trade association which holds itself responsible for the guaranty.

Labeling plans in one form or another have been in operation for many years, and identifying labels (some carrying guaranties) are being advocated by about 100 national technical societies and trade

associations, many of whom maintain inspectors for making their labels effective. Recent investigations have revealed the fact that many firms manufacturing goods on a mass-production basis are willing to make use of quality guaranteeing labels provided they can be assured of sufficient demand for goods thus labeled.

COMMERCIAL STANDARDS

To-day, more than ever, business is turning the spot light into every nook and cranny in order to discover and correct evils and wastes previously overlooked or neglected. It is house-cleaning time for industry, and management is endeavoring to make a thorough job of it. While distribution is receiving considerable attention, there is also a manifest interest in methods of marketing, particularly means of assuring skeptical buyers that the materials delivered are of satisfactory and serviceable quality.

In the present perplexing market of novelties and color, individual buyers and even professional purchasing agents are finding it increasingly difficult to distinguish between items of real merit and products built for "appearance only." It is natural, therefore, that the buyer and the purchasing agent are both seeking authoritative and dependable criteria of quality and are welcoming certificates from reputable producers that the quality of the goods equals or exceeds the commercial standard specification.

The trend during the past decade, on the part of professional purchasing agents, toward full indorsement of specifications as a basis for buying, has resulted in an increasing diversity of purchase specifications. The extended variety of specifications for a given commodity has increased the complexity of the situation and placed added obstacles in the way of continued mass production.

In other industries intense competition and the gradual recession of prices have resulted in a step-by-step lowering of quality, until in some instances entire industries are threatened with obliteration, because the public is losing confidence in the quality or suitability of the materal delivered.

Many industries have recognized these trends toward a demand on the part of the consumer for assurance of quality; toward increasing diversity of specifications; and toward an avoidance of that loss of good will which results from undercutting quality to meet a price. Instead of sitting idly by and meekly accepting the situation, forward-looking groups are taking the initiative in the establishment of commercial standards as a basis for purchase recommended by entire industries, and as a foundation for marketing the commodity and restoring public confidence in its service value.

The commercial standard, developed and established by industry itself, under the observation of the Federal Government, accepted in writing by producers, distributors, and consumers alike, printed and promulgated by the Department of Commerce after acceptance by a satisfactory majority and without active opposition, satisfies all phases of the situation and offers an authoritative and dependable basis for marketing and purchase by all elements directly concerned.

During the year, as a result of general conferences, wide publicity in trade papers, and general circulation for written acceptances, the

success of 16 commercial standards was announced. Twelve of the standards were issued in printed form during the same period.

In general, it may be said that the standards cover nomenclature and definitions to facilitate a better understanding between buyer and seller; dimensions, tolerances, weights, physical, and chemical characteristics, color fastness, and other items, as a basis for daily trade.

AMERICAN MARINE STANDARDS

Aided by facilities and services contributed by the Department of Commerce and the United States Shipping Board, the American Marine Standards Committee promotes the elimination of waste in the construction, operation, and maintenance of ships and port facilities by formulating and promulgating standards of design and practice where such are deemed of economic importance.

As of July 1, 1930, the membership of the committee comprise 360 member bodies, including shipyards, ship repair and docking establishments, ship owners and operators, naval architects, marine engineers, and various educational, commercial, and governmental interests related to marine industry. During the year ended June 30, 1930, there were promulgated 22 standards relating to ship and machine construction and operation. The committee is national in scope and carries on its activities in cooperation with the nationally recognized organizations doing similar work. Serving as advisory members on its executive board are representatives of the American Institute of Electrical Engineers, American Society of Civil Engineers, American Society of Mechanical Engineers, American Society for Testing Materials, National Bureau of Standards, and National Fire Protection Association. Its representatives serve on sectional committees of the American Standards Association.

SCIENTIFIC RESEARCH

Bureau of Standards.—In carrying on its researches for the Federal Government the National Bureau of Standards cooperates effectively with American industries through the medium of its advisory committees and its "research-associate" plan. Advisory committees representing 14 national associations and 24 additional groups, both organized and unorganized, are now aiding the bureau in the formulation of research programs by advice and discussion, and by reviewing the results.

Ninety-six research associates are maintained at the bureau by 41 separate organizations which are being assisted in conducting scientific researches on important problems affecting their industry or specialty.

Through an extensive cooperative investigation on the high-temperature properties of railroad rails, it has at last been found that, owing to the low ductility of certain kinds of steel at the temperature at which rails are rolled, there is a tendency for the formation of nuclei which may later develop into transverse fissures.

Under the auspices of the American Society for Testing Materials there has been established at the bureau a cement reference laboratory with the object of inspecting the numerous cement-testing laboratories of the country and of instructing them in the use of uni-

form testing apparatus and in standardizing test methods. The services of the laboratory are available to everyone interested, and many requests have been received from cement producers all over the United States for the services of the laboratory's inspection force.

A continuing investigation which has led to important results during the past year has been that on the development methods for the fractionation of petroleum and the identification of its constituent hydrocarbons. Several publications have been issued on this subject.

In cooperation with the American Petroleum Institute, the American Gas Association, the Underground Pipe Products Institute, and the Cast Iron Pipe Research Institute, the bureau has begun an extensive field investigation of coatings for protecting underground pipe. The work has been in progress only a short time, but the getting together of these various interests is in itself a real step in advance and will undoubtedly lead to most important results.

A new laboratory for the type testing of airplane engines has been completed at Arlington, Va. The completion of this laboratory with three torque stands has greatly speeded up the important work of testing each new type of commercial airplane engine for the Aeronautics Branch of the Department of Commerce. Four torque stands soon to be installed will take care of all present demands of the laboratory. The vital importance of this work to the public will be appreciated when it is remembered that of 52 engines received for test during the past year, 26 passed, 23 failed, and 3 were withdrawn.

A new and more accurate standard of radio-frequency has been developed. By means of a special installation of quartz oscillators and auxiliary machinery, it is now possible to measure radio-frequency with an error of only 2 parts in 10,000,000. This is of the greatest importance, since the maintenance of transmitting stations closely on their assigned frequency is essential with the present close grouping of high-power transmitting stations.

There has been established, on a satisfactory basis, a new absolute standard of light, which it is hoped will eventually supplant the artificial standards (such as carbon-electric lamps) now used. This standard involves a measurement of the brightness of a surface of pure metal, such as platinum, at its freezing point. While simple in theory, the development of this standard to a satisfactory working basis has involved many difficulties.

The work on establishing a series of standard filters by which light from artificial sources can be changed in character so as to duplicate daylight has met with great success, and one of these has been recommended for adoption as an international standard for the production of artificial sunlight by the Seventh International Congress on Photography.

UTILIZATION AND CONSERVATION OF NATURAL RESOURCES

Mineral.—In cooperation with the American Gas Association, the Bureau of Mines has developed a method and apparatus for determining the gas-making, coke-making, and by-product-making properties of American coals. The properties of the coal as shown, not only by the usual chemical analysis but by new and less usual physical and chemical tests and microscopic examination, are being correlated with the carbonization results.

For the purpose of assisting in differentiating between bituminous and subbituminous ranks of coal, the bureau is cooperating with a sectional committee of the American Standards Association in developing an accelerated test for determining the slacking or weathering properties of coal. Friability tests for determining the resistance to breakage of coal are also being developed.

During the past year the bureau has greatly improved the methods and apparatus for air elutriation of fine powders.

Investigations conducted by the Bureau of Mines have resulted in the accumulation of much valuable information regarding our resources in helium, the nonimflammable gas, the use of which in lighter-than-air dirigibles is considered so essential from the point of view of safety. A source of supply of the gas in quantity sufficient for the needs of the Government has been located in the Texas field.

Products of the soil.—The utilization of waste-land products is an important field of industrial research in which the Bureau of Standards is active.

Wastes from the corn and sugar-cane plants are similar in nature in that they involve the stalks and leaves, and the cob in the case of corn. At least 100,000,000 tons of these products are commercially available annually in the United States but are wasted and await the call for conversion into valuable products. The cornstalk consists of a very light inside pith and an outside fibrous shell. The pith is being converted into insulating materials resembling cork products. The fibrous shell is being made into a variety of crude and refined cellulose products, including a horny product called maizolith, which is suitable for making gears, bushings, electrical fixtures, and other products requiring toughness, strength, and electrical insulating properties. The shell fibers are converted into wall board for insulating the walls and ceilings of houses. They may be waterproofed and fireproofed. They may be painted and can also be covered with plaster for interior finish. The thick boards may be used to insulate the interiors of refrigerator cars, household refrigerators, and ice houses. The wet, loose, porous sheets may be steam heated under pressure to form a strong cornstalk lumber. Similar products made from bagasse have wide markets.

In the semicommercial plant maintained by the Bureau of Standards in cooperation with Iowa State College at Ames, Iowa, the process of making wall board from cornstalks has proved so satisfactory that it is now in commercial use. At the bureau's plant a board one-half inch thick and twice as strong as any on the market was made from what has heretofore been a waste product.

The cornstalk fibers give good grades of pulp with proper chemical and physical treatments. Newspapers and book papers have thus been made. As side products, xylan adhesives and carbon black are obtained. When further refined, the pulp yields a high-grade, pure alpha cellulose, which has been used to make transparent glassine papers, viscose, and rayon textiles.

The cotton plant is the source of millions of tons of waste such as the stalks, burs, leaves, seed hulls, and their adhering short fibers or fuzz. Only the cottonseed hulls find use, namely, as a low-grade cattle feed or roughage. More than 1,500,000 tons of cottonseed hulls are produced annually in this country. Work by the Bureau

of Standards has developed commercial possibilities for separation and utilization of the fuzz and the broken shells called cottonseed bran. The fuzz or very short cotton fibers can be readily purified by chemical treatments to form pure alpha cellulose suitable for manufacture into rayon, nitrocellulose films and plastics, and lacquers, cellulose acetate, and high-grade paper.

The hull bran has been found to contain about 40 per cent of pentose sugars, especially xylose. Although this sugar has been sold for $100 a pound, laboratory and semicommercial work by the bureau has shown that it can be made on a practical scale for less than 25 cents a pound. Work is under way to convert the xylose into sugar acids like citric and tartaric acids, lactic and acetic acids, alcohol and acetone, furfurol, and other products by chemical and fermentation methods. Its possible use in human and animal foods is being investigated in cooperation with medical and animal experimenters.

Cottonseed bran can be used in manufacturing many kinds of molded products such as electrical fixtures, rollers, chair backs, table tops, and the like.

Straws and hulls from wheat and oats and other cereals are wasted annually to the extent of tens of millions of tons. Work is under way to convert the straw into high-grade pulp and paper products. Already they are used in low-grade papers and box boards. Oat hulls are the source of the new and widely used commercial chemical, furfurol, entering into plastics and binders for abrasive wheels and electrical apparatus. The straws offer possibilities for production of producer gas for household use by fermentation, combustion, and distillation methods.

Fisheries.—New uses for the various products of the fisheries have been developed by the Bureau of Fisheries.

As a result of its study of the methods of manufacturing fish meal, fish oil, and related by-products, the bureau has demonstrated that the adoption of the low-temperature drying process, in preference to drying by intense heat, would reduce loss of material and provide higher-quality fish meals.

For instance, scientific research and carefully controlled feeding experiments by the bureau's chemists and technologists have demonstrated that steam and vacuum-dried fish meals have a greater nutritional value than flame-dried fish meals.

The bureau is urging the use of fish meal as a feedstuff rather than as a fertilizer. Nutrition studies have shown that the method of manufacture frequently has more influence on the nutritional value of the meal than the nature of the raw material.

Nutrition research, not only on fish and shellfish meals, but on other marine products, both for human and animal consumption, is contributing a great deal toward the establishment of new dietary standards.

As an example of work along these lines, chemists of the Bureau of Fisheries and the Bureau of Chemistry and Soils, through a cooperative research program, have shown that salmon, sardine (or pilchard), and tuna oils now used in the arts and industries are a cheaper source of vitamins for animal feeding, as the oils are now prepared, than cod-liver oil. Recommended improvements in the

methods of production of these fish oils, soon to be published upon completion of the work, will probably increase their vitamin content.

Recent experiments by the bureau also have shown that marine products are not only an excellent source of such minerals as calcium and phosphorous, but also contain the less common elements which play an important rôle in nutrition.

Filleting, packaging, refrigeration, and other modern methods of handling fresh fish at their source have created new problems in connection with the utilization and conservation of our natural resources from the sea, with resultant rapid strides of progress in the elimination of waste in these industries. When fish were shipped "in the round," the housewife discarded the fish cuttings into the garbage can, thereby wasting a potential animal feed of unexcelled nutritional value. Now this refuse is concentrated at the points of production and is being converted into fish meal, oil, and other by-products of considerable commercial importance.

The bureau's efforts toward conservation of the aquatic resources of the country are more effective in Alaska, where actual control of the fishery industries is exercised by law. Through continued vigilance and judicious modification of fishery regulations, a high degree of success is obtained in assuring an escapement of 50 per cent of the total salmon run, permitting an adequate number of spawning fish to reach the head waters of rivers to seed the spawning beds. Progress is being made through scientific studies to determine the maximum return from a known spawning, with the result that the industry is permitted to take greater quantities of adult fish for canning than heretofore without endangering the food supply. As a result of the fearless conservation policy, highly productive runs of salmon are being maintained, and those already depleted show signs of eventual rehabilitation. By encouraging the States to enact such legislation as will prevent the destruction of immature and undersized fish and that will outlaw unusually destructive fishing practices, the bureau has done much to further conservation throughout the country.

The development of the science of water farming has also acted as a conservation measure. Through improved methods of rearing of warm-water pondfishes, waste-water areas have been recovered for food production and means for increasing the productivity of waterways are being devised.

Improvements in methods of rearing fish in hatcheries are also being made through the control of diseases by improved diets permitting the rearing of fish to larger sizes before releasing them in streams and through the production of superior strains of brood stock showing rapid growth, yielding a large number of eggs, and possessing disease-resisting qualities.

Active conservation measures are applied to the prevention of the destruction of young seaward-migrating salmon by the entering of irrigation ditches. Improved types of fish screens have been installed on various reclamation projects, assuring the safe passage of fish to the sea.

Increased utilization of the natural supply of food fish in the sea will result from predictions of variations in abundance. In the North Atlantic mackerel fishery, the great abundance of mackerel

during the current season was foretold during the early spring, with the result that preparations were made to harvest and distribute the crop to better advantage.

Wood utilization.—During the past fiscal year the National Committee on Wood Utilization carried on 14 different projects relating to the elimination of waste in the manufacture, distribution, and consumption of wood products.

On the basis of answers to questionnaires sent to sawmills and woodworking factories in North Carolina, the committee prepared a report entitled "Survey of Nonutilized Wood in North Carolina," showing the locations of 32,000 carloads of wood waste. This tabulation gives the names of the mills, and the kind, species, and quantity of each wood-waste item. The printed report accompanying these tables gives constructive suggestions on the subjects of reducing wood waste to a minimum and profitable disposal of wood-waste products. During the year another similar survey has been carried on in the State of Maryland.

The committee's work on the utilization of discarded wooden containers was continued. One hundred and fifty thousand bulletins of of its You Can Make It series were sold, and wood-utilization contests were staged in many States. The manuscript of a new bulletin entitled "You Can Make It For Camp and Cottage" was sent to the printer during the latter part of the fiscal year.

In order to make chemically treated lumber—which is resistant to decay and insect attack—available to the average small consumer, the committee, in cooperation with the Ohio Retail Lumber Dealers Association, has arranged for the wholesale and retail distribution of this commodity. The committee has published a booklet entitled "Treated Lumber—Its Uses and Economies," which demonstrates how this material may be used on the farm and in building and construction, thereby decreasing the expenses of upkeep and repair and extending the life of the structure. The Ohio project is now to be extended into other States, and the committee plans to have it carried on as a nation-wide undertaking.

In the wood-construction field the committee has cooperated with the Federal Board for Vocational Education and has compiled a handbook to be published shortly under the title of "Light Frame Construction." This book has been prepared for the benefit of carpenters and builders.

The committee is also working on a smaller publication entitled "How to Judge a House." This booklet, destined for the nontechnical, prospective home buyer, analyzes features of construction and design in connection with the average small house, the object being to enable the nontechnical consumer to check up on his purchase of a home.

The committee is now compiling a handbook on wooden airplane hangar construction, to be based on the fire tests conducted at the Bureau of Standards during the spring of 1930, under the auspices of the Fact-Finding Committee on Automatic Sprinkler Protection for Airplane Hangars. The National Committee on Wood Utilization participated in these tests.

Following successful tests of Scandinavian gang saws, introduced into this country through committee efforts, a bulletin entitled "Test

of Scandinavian Gang Saws on the Pacific Coast" was published. This gives detailed information in regard to this venture on the Pacific coast.

The manufacture of ready-to-use small-dimension stock is an important phase of efficient wood utilization. The committee has made a field study of this subject and has published a booklet under the title of "Small Dimension Stock—Its Seasoning, Handling, and Manufacture." This book analyzes the most efficient methods of producing small dimension stock. It will soon be followed by another booklet written for the consumers of this class of lumber.

A systematic drive was made during the year, in cooperation with trade and professional associations, to direct the attention of lumber buyers to the protection afforded them in specifying grade-marked lumber in their purchases.

The preliminary work has been done on the compilation of the manuscript of a booklet entitled "How to Judge Furniture." The construction of furniture and its design will be given adequate treatment so as to enable the nontechnical furniture buyer to judge furniture values.

HUMAN SAFETY

In mining.—In making recommendations on standard mining practice to the mining industry, the Bureau of Mines bases its formal decisions on the findings of its mine safety board, which is made up of representatives of the different technical divisions of the bureau.

Much information of value in solving problems confronting mine operators is being developed by the Bureau of Mines. In this bureau's experimental mine the relative explosibility of coal-mine dust from different mines of the country is tested from time to time to ascertain the proper means of preventing coal-dust explosions. Tests are being made of the factors in general rock dusting for the prevention of coal-dust explosions, for the purpose of modifying the code on such dusting formulated by the Bureau of Mines and approved by the American Standards Association.

Electrification of the coal-mining industry has created new hazards. The bureau is constantly conducting tests of various types of electrical equipment used in mines with a view to the development of "approved" designs that eliminate these hazards as much as possible. As faultily designed miners' lamps have caused many mine explosions, the bureau has led the way in the development of "permissible" lamps which are far safer than those previously used. The permissible type of explosive, the use of which is rapidly being extended throughout the mining industry as a result of the bureau's tests and educational campaign, is also much safer than other types of explosives.

With a view to complying with regulations for the operation of coal mines on the public domain, the Bureau of Mines and the Bureau of Standards are carrying on a cooperative investigation relating to the strength of mine stoppings that will resist explosions.

Definite routine tests to determine the safety of gas masks when worn in known concentration of various mining and industrial gases have been adopted by the Bureau of Mines. The bureau has conducted courses of instruction in standardized methods of mine rescue

procedure and has given demonstrations in the proper use and limitations of rescue apparatus. Its handbook on self-contained, mine-rescue, oxygen-breathing apparatus has been revised, enlarged, and reissued. Its manual of instruction in first aid has also been revised, enlarged, and reissued.

For a number of years the bureau has fostered the holding of a considerable number of contests to train miners in methods of first aid to the injured. More than 100 of these contests are now being held annually with the cooperation of the Bureau of Mines personnel.

Members of the staff of the Bureau of Mines have participated actively in the work of the mining standardization correlating committee functioning under the procedure of the American Standards Association.

The factory and the home.—Members of the staff of the Bureau of Standards have taken an active part in the work of the Safety Code Correlating Committee and in committees preparing safety codes for various industries.

A new edition of the Elevator Safety Code, of which the Bureau of Standards is a sponsor, was prepared during the year.

In cooperation with the General Federation of Women's Clubs, the Bureau of Standards made a survey of accidents in the homes of club women in North Carolina, as part of a movement to reduce accidents in the home.

By sea and air.—Of the several agencies of the Department of Commerce that are charged with the duty of maintaining safety in travel by water and air, the Bureau of Navigation and the Steamboat Inspection Service deal with the safety of travel on merchant vessels, while the Bureau of Lighthouses and the Coast and Geodetic Survey deal with both water and air navigation.

The Bureau of Navigation, through its fleet of inspection vessels, navigation inspectors, and marine divisions of the customhouses, enforces the law covering life-saving equipment and navigation, in accordance with the rules of the lane, of over 250,000 small vessels, and assists in the enforcement of the law covering the equipment and navigation of every vessel operating in our foreign and coastwise trade; it enforces the rules governing the patrol of the course during regattas and marine parades, and through the operation of its navigation inspectors, in cooperation with other services, prevents the overcrowding of excursion steamers; it enforces the St. Marys River rules affecting a commerce larger than that which passes through the Suez Canal.

Under the direction of the Steamboat Inspection Service a committee is working upon the draft of a boiler code that will represent the best modern practice in boiler construction, inspection, etc. In accomplishing this work, the committee is taking the best from all present boiler codes, so that when the new code is completed all boilers can be constructed to the code.

As a part of its contribution to safety by sea and air, the Bureau of Lighthouses has replaced all obsolete spark transmitters on lighthouse tenders with the latest type of tube or modulated continuous-wave transmitter and has continued the practice of replacing worn-out steam fog-signal plants with more modern equipment.

Improvements are being made in the light from the masthead of lightships, by increasing the divergence of the beam.

During the year, 30 low-power radiobeacon transmitters operating on 60-cycle current and emitting signals at from one to five tones from 400 to 1,600 cycles were installed at harbor approaches and at points of lesser importance. The radiobeacons are operated for a definite period each hour during clear weather.

To enable the navigator to determine his distance from a radiobeacon station at any time when he can hear a sound signal, synchronized radiobeacon and sound-in-air signals have been installed at six stations, including the one at Cape Henry, where the first installation was made in 1929.

To increase safety in servicing the many gas buoys in the Lighthouse Service, acetylene gas buoys having tanks or flasks within the body of the buoy are being modified so that these buoys will all be provided with gas-tight steel pockets for individual flasks with capacity little more than the flask itself, thus avoiding opportunity for dangerous explosions due to accumulation of gas within the large inclosure of the buoy body. The gas piping is changed to run outside of the buoy body.

The establishment of Poe Reef Light Station and Fourteen Foot Light Station in Lake Huron, near the track of steamers, taking the place of Poe Reef Light Vessel and Cheboygan Point Light Station, adds materially to the safety of navigation. Poe Reef Light Station exhibits a light throughout the year and is a greater safeguard than the lightship it displaces, both at the close of navigation in the fall and opening of navigation in the spring.

The net increase of 555 aids to navigation during the year, including 141 new automatic lights, 75 gas buoys, 14 radiobeacons, 51 fog signals, and 249 unlighted buoys, etc., has materially added to the safety of navigation both for the increasing number of larger and faster vessels and similar types of vessels on inland routes.

That the United States Coast and Geodetic Survey is recognized as a leader in hydrographic and geodetic theory and practice is shown by the fact that its standards and specifications for this kind of work are being adopted by other nations.

In its magnetic work the survey is cooperating actively with the department of terrestrial magnetism of the Carnegie Institution of Washington, and the international meteorological committee of the Commission on Terrestrial Magnetism and Atmospheric Electricity.

The nautical charts of the Coast and Geodetic Survey constitute an important part of the equipment essential to the safe navigation of all ships. Over 700 in number, they represent a shore line, including indentations, of more than 103,000 miles. As it is obviously impossible to portray graphically all data of value, a series of 12 volumes of Coast Pilots furnish the mariner with the additional information needed with respect to ports, harbors, and natural features.

The remarkable strides made by this country in commerce and industry, with an increasing number of ports and larger ships, and the great changes which have taken place, particularly along the south Atlantic and Gulf coasts due to erosion and deposition and to improvements of waterways, have constantly necessitated a revision of previous surveys and an extension seaward of the areas so surveyed, in the interests of human safety. The rigid requirements of to-day, therefore, stipulate an exactness of detail, made possible

in a large measure by modern equipment, that was as impossible as it was unnecessary years ago.

The large, swift vessel of to-day, representing not only a large investment but carrying a passenger list of 2,000 and more, operates on an exacting schedule that makes no material allowance for fogs, shoals, and other menaces to navigation. With a modern nautical chart showing the configuration of the bottom in detail, the navigator can without reducing speed fix his position from underwater landmarks by means of an electrical depth-registering device just as he uses other aids and outstanding visible topographic features on approaching land, also shown on his chart.

The mariner is likewise enabled to maintain his schedule by the published predictions of tides and currents as well as the advance publication of current charts for certain ports. The latter, already published for New York Harbor, will shortly be issued for San Francisco Bay, to be followed by similar data for other harbors. In thick weather, particularly in a large port congested with traffic, accurate knowledge of the velocity and direction of the current and the time of occurrence of slack water, where swift and dangerous tidal currents exist, is a further insurance against possible loss of life.

The chart contains information regarding the variation of the compass, in the form of "compass roses," on which the direction of the magnetic north, or the direction indicated by the compass, is shown in its relation to the true north. The annual change of the variation is also given, so that the mariner may make allowance for the change between the date of issue of his chart and the date of its use. This information is based on observations of the earth's magnetism at numerous places all over the country and in the adjacent water areas, from which the variation of the compass may be ascertained at any desired place.

Airway maps, compiled to meet the special requirements of the aviator, are also issued by the Coast and Geodetic Survey. The unusual demand for these maps is indicative not only of the growth of aviation but of the amount of dependence placed upon this aid to safety by those who fly over unfamiliar territory.

The soundings shown on nautical charts, as well as the topographic features on these charts and the airway maps, would constitute a danger rather than a safeguard unless shown with geographical correctness. These positions are therefore accurately fixed by means of a basic geodetic control survey, whereby by means of triangulation and precise leveling thousands of so-called stations throughout the United States will eventually be established and furnish a rigid framework upon which details of all maps and charts and engineering work may be constructed.

Cutting the loss from major disasters is of the utmost importance as our country becomes more densely populated and the possible loss increases. In the case of earthquakes, the Coast and Geodetic Survey is conducting studies of their actual movements in the region of greatest intensity, to meet the needs of the engineer and architect in designing earthquake-resistant structures.

Along streets and highways.—In carrying forward its program aimed at the reduction of highway traffic accidents, the National Conference on Street and Highway Safety revised and brought down

to date model acts and ordinances to serve as guides in the preparation, during 1931, of State and municipal laws relating to traffic.

In the spring of 1930 five new committees of the National Conference on Street and Highway Safety completed their reports. These committees dealt, respectively, with the subjects of (*a*) protection of railway grade crossings and highway intersections, (*b*) maintenance of the motor vehicle, (*c*) measures for the relief of traffic congestion, (*d*) traffic accident statistics, and (*e*) uniform traffic regulation.

The committee on uniform traffic regulation made a review in the light of the most recent experience of the various standards which had previously been developed in connection with the conference work—the Uniform Vehicle Code for States, the Model Municipal Traffic Ordinance, and the Manual on Street Traffic Signs, Signals, and Markings.

The reports of these five committees, including the above-mentioned standards codes as revised, were reviewed by the Third National Conference on Street and Highway Safety, which was held in Washington, May 27–29, and was participated in by public officials and private citizens representing all parts of the country and all interests concerned in motor traffic, including delegates appointed by the governors of 42 States. The conference considered all of these reports and adopted a summary of recommendations, including the findings of all conference committees and of the general meetings held in 1924, 1926, and 1930. This summary is printed in a pamphlet entitled "Ways and Means to Traffic Safety," which, together with the reports of the committees and the revised standards, has been widely distributed.

Substantial progress is being made in the adoption of the conference standards. Although only a few of the State legislators met in 1930, 25 States have now enacted laws based on the Uniform Vehicle Code. The Model Municipal Traffic Ordinance has been put into effect in all municipalities in New Jersey, New York, and Wisconsin by State legislation, while it has been adopted by numerous cities and towns in other States, as has the Manual on Street Traffic Signs, Signals, and Markings.

PROGRESS IN DEVELOPMENT OF CIVIL AERONAUTICS

In addition to its regular duties of examining aircraft and airmen for license; maintaining and extending the Federal airways system; assisting communities in the selection of airports; conducting research on problems of air navigation, including aeronautic radio; enforcing the Air Commerce Regulations; determining the causes of civil aircraft accidents; and furnishing the public with information pertaining to civil aeronautics, the Aeronautics Branch of the Department of Commerce during the fiscal year 1929–30 developed and placed in effect the following:

1. Regulations requiring operators of scheduled interstate passenger air-transport services to obtain from the Secretary of Commerce a certificate of authority to operate such services. The certificate will be issued only to those operators who comply with the regulations and the interpretations thereunder.

2. Regulations providing for approval by the Department of Commerce of gliders as to airworthiness and for the licensing of gliders and glider pilots.

3. Regulations providing for the examination, test, and issuance by the Department of Commerce of approved type certificates for parachutes and also for the creation of a "parachute rigger's license." The examination, test, and issuance of approved-type certificates for parachutes are made upon application by the manufacturers of parachutes.

Regulations providing for the examination and rating by the Department of Commerce of civilian schools giving instruction in flying, as to the adequacy of the course of instruction, as to the suitability and airworthiness of the equipment, and as to the competency of the instructors, were promulgated shortly before July 1, 1929. However, the certificates of approval were not issued until the fiscal year just closed.

Under its program of airways development, the Aeronautics Branch during the last fiscal year lighted 3,321 miles of airways, established and lighted 56 intermediate landing fields, and installed and operated 218 standard revolving beacon lights for the guidance of airmen after dark. Five thousand six hundred and fifty miles of airways were equipped with automatic telegraph typewriter circuits which collect and disseminate weather information along the airways, and 13 radio broadcasting stations were placed in operation for the broadcast of this weather information to planes in flight at regular intervals, both day and night. Two radio range beacons, which guide pilots along the airways by means of radio signals, also were placed in operation, and 27 were completed to the point where service operation will be started between July 1 and September 1, 1930.

As the foregoing aids to air navigation not only have justified their existence but have proved to be indispensable from the stand-

point of safety and reliability of aircraft operation, funds available from current appropriations have been allocated to provide more of these facilities. During the current fiscal year 3,000 miles of additional airways will be lighted, 33 radio range beacon stations will be established, 2,800 miles of automatic telegraph typewriter circuits will be placed in operation, and 20 radio-communication stations will be installed. Upon the completion of these 20 additional radio-communication stations there will scarcely be a square mile of area in the United States (where flying is a regular activity) in which a pilot can not receive broadcasts of weather information while in flight.

Airport specialists of the Aeronautics Branch engaged in 871 conferences with cities and municipalities, assisting them in the selection of sites and supplying information as to the requirements for the development of suitable airports.

At the close of the fiscal year 1929–30 the status of active licenses and approvals, issued by this service following examinations and inspections, was: Licensed planes, 6,684; unlicensed planes, 3,089; licensed pilots, 13,041; licensed mechanics, 8,843; aircraft holding approved-type certificates, 334; engines with approved-type certificates, 54; propellers with approved-type certificates, 174; aircraft approved for license but without approved-type certificates, 230; approved civilian schools giving instruction in flying, 45.

Under its aeronautic development program, the Aeronautics Branch organized special cooperative research committees which undertook studies of such subjects as:

1. The effectiveness of the automatic application of water in controlling airplane hangar fires.

2. The development of standard signal systems for airports which will be suitable for both day and night use for controlling traffic on and in the vicinity of airports and for communicating special information to pilots.

3. Aeronautic radio research now in progress and of those radio problems the solution of which will assist in bringing about the highest degree of safety and reliability in air transportation.

4. Hazards that might be developed in the vicinity of airports through the construction or existence of buildings, smokestacks, radio towers, and similar obstructions to air navigation.

5. The problems involved in airport drainage and surfacing. In this latter study, the Aeronautics Branch has the cooperation of the American Engineering Council and the American Road Builders Association.

The comparatively new aeronautic industry, along with many of our older industries, became involved in the general depression which occurred last fall and winter. This, together with expansions and extensions which had been made in greater proportions than are acceptable as sound business practices, resulted in the withdrawal from the industry of the insecure and the unprepared who rushed into aeronautics to supply a demand that did not live up to their anticipations.

While the manufacturing phase of the industry has not produced as many planes during the fiscal year just ended as it did in the

previous period, scheduled air transportation continued to expand in accordance with carefully laid plans and now renders a distinct service to the Nation. Its future under the provisions of the Watres Air Mail Act is indeed promising.

Free from the uncertainties of inflated securities, free from over-enthusiastic support and activity by elements not thoroughly schooled in the economics of manufacture, production, and marketing, commercial aeronautics stands to-day as a young industry with bright prospects, provided it follows the same course that has marked the success of the older established industries and institutions.

CONDENSED REPORTS OF BUREAUS

CHIEF CLERK AND SUPERINTENDENT

DEPARTMENT OF COMMERCE,
OFFICE OF THE CHIEF CLERK,
Washington, July 1, 1930.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: Although demands were unusually heavy upon all divisions of the Secretary's Office during the year, the personnel responded to a marked degree and enabled us to give satisfactory service to all branches of the department. Overtime work performed by 63 employees amounted to 341 days.

Lack of sufficient space to properly care for the needs of the department was a continuing handicap to efficient administration. The early completion of the new Commerce Building, however, enables us to see in the near future the end of this perplexing problem.

INTERNATIONAL EXPOSITION AT SEVILLE, SPAIN

The department participated in the Ibero-American Exposition at Seville with the United States Government group from May 9, 1929, to June 21, 1930. All bureaus were represented; those activities thought to be of value or interest to modern Spain being emphasized. Among these were commercial aviation, radio services, mining, scientific standards, and the department's services touching the merchant marine and foreign trade.

Industrial and commercial America was presented by means of an extensive assortment of educational motion pictures. These were exhibited daily at free shows in the motion-picture theater. Industrial subjects on miniature films were also shown on two continuous automatic projectors within the department's exhibit.

The department's exhibits were awarded 24 prizes—including 7 awarded to commercial collaborators—namely, 2 grand prizes, 9 medals of honor, 9 gold medals, and 4 silver medals.

DISBURSING OFFICE

The table following shows the total amount of all appropriations for the various bureaus and services of the department for the fiscal year ended June 30, 1930:

Bureau	Annual appropriation act	Deficiency act	Special act	Total	Allotments by other departments
Office of the Secretary	$752,200.00			$752,200.00	
Aeronautics Branch	6,416,620.00	$259,700.00		6,676,320.00	
Radio Division	460,000.00	30,000.00		490,000.00	
Bureau of Foreign and Domestic Commerce	4,539,923.00			4,539,923.00	
Bureau of the Census	18,900,000.00	5,740,000.00		24,640,000.00	
Steamboat Inspection Service	1,187,220.00	4,948.00		1,192,168.00	
Bureau of Navigation	352,040.00	17,415.00	$2,192.67	371,647.67	
Bureau of Standards	2,506,746.00			2,506,746.00	$215,847.00
Coast and Geodetic Survey	2,515,860.00	21,326.48		2,537,186.48	3,600.00
Bureau of Lighthouses	11,349,980.00	420,000.00		11,769,980.00	
Bureau of Fisheries	1,958,550.00	20,000.00		1,978,550.00	
Patent Office	3,333,800.00	105,666.67		3,439,466.67	
Bureau of Mines	2,249,670.00	205,000.00		2,454,670.00	254,200.00
Printing and binding:					
All bureaus except Patent Office	615,000.00	34,300.00		649,300.00	
Patent office	1,100,000.00			1,100,000.00	
Total	58,237,609.00	6,858,356.15	2,192.67	65,098,157.82	473,647.00

Disbursements during the year ended June 30, 1930, from appropriations and from funds transferred from other departments were as follows:

Bureau	Appropriation for—			Total
	1928 and prior years	1929	1930	
Office of the Secretary	$13,678.62	$619,122.05	$2,166,440.08	$2,799,240.75
Aeronautics Branch	113,519.14	1,337,437.63	5,183,835.75	6,634,792.52
Radio Division	83,088.36	73,097.42	456,696.83	612,882.61
Bureau of Foreign and Domestic Commerce	6,795.00	317,920.39	4,409,950.99	4,734,666.38
Bureau of the Census	182.54	247,878.38	14,334,258.56	14,582,319.48
Steamboat Inspection Service	10.00	111,459.63	1,150,228.33	1,261,697.96
Bureau of Navigation		29,817.87	349,632.50	379,450.37
Bureau of Standards	4,335.25	386,025.70	2,580,665.07	2,971,026.02
Coast and Geodetic Survey	5,187.42	535,304.41	2,115,905.77	2,656,397.60
Bureau of Lighthouses	5,263.56	797,781.32	10,720,229.50	11,523,274.38
Bureau of Fisheries	238.01	327,327.74	2,110,347.37	2,437,913.12
Patent Office	213.36	315,257.45	3,364,083.45	3,679,554.26
Bureau of Mines	20,439.39	320,237.51	3,687,455.37	4,028,132.27
Total	252,950.65	5,418,667.50	52,629,729.57	58,301,347.72

The miscellaneous receipts for the fiscal year are shown below, by bureaus.

Coast and Geodetic Survey: Sale of charts, publications, old property, etc	$75,713.89
Bureau of Fisheries:	
Sale of fur-seal skins	240,777.92
Sale of fox skins	32,029.80
Sale of otter skins	922.38
Meals furnished employees at isolated stations	681.31
Sale of old property, etc	2,803.78
Bureau of Standards:	
Test fees	72,370.54
Miscellaneous refunds	311.00
Steamboat Inspection Service: Sale of old property	89.76

Bureau of Lighthouses:	
Sale of old property	$1,562.19
Rent	4,298.77
Government property lost, destroyed, or damaged	5,898.44
Work done	4,360.93
Sale of land and buildings	15,010.31
Miscellaneous refunds	1,377.76
Bureau of Foreign and Domestic Commerce:	
Registration fees, etc., China trade act	1,625.00
Sale of publications	3,786.35
Sale of old property	2,693.55
Miscellaneous refunds	54.79
Office of the Secretary:	
Certification fees (37 Stat. 497)	381.00
Sale of strip maps (Aeronautics Branch)	3,130.10
Penalties for violation air traffic rules	5,705.00
Miscellaneous refunds	304.29
Patent Office: Patent fees	3,990,042.25
Bureau of Mines:	
Analyzing samples	6,712.00
Sale of gas from helium plants	7,193.54
Rental of pipe lines	17,500.00
Sale of property	99,812.27
Miscellaneous refunds	1,821.15
Bureau of the Census: Sale of property	591.00
Radio Division: Miscellaneous refunds	57.90
Bureau of Navigation:	
Tonnage tax	2,021,295.94
Navigation fees	236,781.02
Navigation fines	62,593.23
Miscellaneous refunds	24.50
Miscellaneous: Refund of gasoline tax	1,209.37
Total	6,921,523.03

APPOINTMENT DIVISION

At the close of the year the personnel of the department numbered 26,955 (15,969 permanent and 10,986 temporary). Of the total number, 9,418 are employed in the District of Columbia and 17,537 constitute the field force.

The number of employees retired on annuity during the year under the civil service retirement act was 32—19 by reason of age and 13 on account of disability. The average annuity of those retired under the act is $854.57. Under the Lighthouse Service retirement system 38 were retired for age with an average annuity of $1,062.81 and 17 on account of disability with an average annuity of $1,255.37. A total of 841 employees have been retired under the two systems to the close of June 30, 1930.

DIVISION OF PUBLICATIONS

The following statement shows for the fiscal years 1929 to 1931, inclusive, the amounts available for printing and binding and the unexpended balances of the appropriations for 1929 and 1930.

	1929	1930	1931
Services other than Patent Office:[1]			
Amount available	$715,000.00	[2] $649,300.00	$645,000.00
Expenditures	715,000.00	[3] 634,685.72	
Balance		14,614.28	
Patent Office:			
Amount available	[4] 1,140,235.77	1,100,000.00	1,100,000.00
Expenditures	1,042,358.42	[3] 1,097,621.72	
Balance	97,877.35	2,378.28	

[1] Does not include the Bureau of the Census for 1930 or 1931. During the decennial census period (1930, 1931, and 1932) the cost of printing and binding for that bureau is paid from appropriations for the Fifteenth Decennial Census.
[2] Includes $34,300 contained in the first deficiency act, fiscal year 1930.
[3] Estimated. Exact figures can not be given until all work ordered is completed and billed.
[4] Includes $235.77 credited to appropriation by reason of a payment by private corporation for cost of printing two briefs.

Total receipts from sales of the department's publications for the fiscal year 1929 (the latest period for which complete data are available) were $677,045.17, compared with $651,926.48 for 1928. The following table presents the details in comparison for the two years by selling agencies and issuing offices:

Sales	Receipts	
	1928	1929
By the Superintendent of Documents: Miscellaneous sales and subscriptions	$238,103.15	$231,376.56
By Coast and Geodetic Survey: Coast pilots, inside route pilots, tide tables, current tables, charts, and airway maps	62,057.33	67,390.91
By Patent Office: Specifications of patents, reissues, *etc.*, trade-mark section and decision leaflet of Official Gazette, and classification bulletins and definitions	351,766.00	378,277.70
Total	651,926.48	677,045.17

DIVISION OF SUPPLIES

Following the practice of former years, through the cooperation of the Chief Coordinator's Office, surplus material, comprising laboratory equipment, helium cylinders, boats, generators, office devices, etc., was obtained from surplus stocks of other departments to the value of approximately $513,000 without transfer of funds.

TRAFFIC OFFICE

In cooperation with various bureaus of the department and the Federal coordinating agencies the traffic office has been able to effect substantial savings in both freight and passenger transportation costs, quoting in advance rates, fares, and charges, together with proper method of preparing shipments in order that contracting, shipping, and traveling officers could protect their appropriation. Passengers have used round-trip, reduced, or through rates, and have also taken advantage whenever possible of Government-operated ships. Freight has moved by ships of this and other departments, and land-grant rail routes have been used whenever possible.

DEPARTMENT LIBRARY

The department library contributed largely to the success of informational undertakings of the department. While most of its endeavors are hidden in the mass of statistical matter published by the department, the research work of the library can be measured by the department's output of studies and world-trade surveys, a single one of which may require the use of several hundred books. (Demands upon the library are steadily increasing, but its usefulness is greatly hindered by lack of space.)

The department library is one of the most active of all Government libraries and perhaps the leading of all reference libraries. It has a collection of books and periodicals on commerce and related subjects unsurpassed in Government or other libraries. Upon its shelves are books to the number of 145,000 and periodicals and newspapers to the number of 2,307.

SOLICITOR'S OFFICE

During the year 613 contracts, 1,120 leases, 28 insurance policies, 22 revocable licenses, 19 deeds, 226 contract bonds, 65 annual bid and performance bonds, and 101 official bonds were examined and approved, disapproved, drafted, redrafted, or modified. The number of legal opinions rendered, formal and informal, totaled 309; legislative matters handled which concerned the Department of Commerce numbered 242; power of attorney cards authorizing agents to execute official and contract bonds for surety companies totaled 3,975. In addition, 10,755 miscellaneous matters embracing everything submitted for advice or suggestion of the Solicitor, or for the formulation of departmental action, not included in the foregoing items, were handled by the Solicitor's Office.

Very truly yours,

E. W. LIBBEY,
Chief Clerk and Superintendent.

AERONAUTICS BRANCH

DEPARTMENT OF COMMERCE,
OFFICE OF THE ASSISTANT SECRETARY FOR AERONAUTICS,
Washington, July 1, 1930.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: In compliance with your request, the following report is submitted describing the state of air commerce and briefly summarizing the activities of the Aeronautics Branch of the department during the fiscal year ended June 30, 1930.

ORGANIZATION AND FUNCTIONS

The air commerce act of 1926, which charged the Secretary of Commerce with the responsibility of promoting and regulating air commerce, and which created an additional Assistant Secretary of Commerce to administer the details of this work, marked the beginning of a comprehensive, organized effort to establish aeronautics as a substantial factor in the general transportation scheme of the Nation.

Shortly after the approval of the air commerce act by the President, the Aeronautics Branch was organized. On June 30, 1930, it completed its fourth year of activities. The Aeronautics Branch has created new divisions and sections when necessary in order to execute the various provisions of the act.

As a result of the increased activities, it was found necessary in November, 1929, to decentralize further the duties of the organization. Previously, all the activities were coordinated under the direct supervision of the Assistant Secretary of Commerce for Aeronautics, the Director of Aeronautics being in immediate charge.

Under the new plan, the Assistant Secretary of Commerce for Aeronautics is assisted by three executives—the director of air regulation, the chief engineer of the airways division, and the director of aeronautic development. These three officials are responsible to the Assistant Secretary, as are the chiefs of the administrative division and the helium section.

The Assistant Secretary as chairman, and the three executives constitute the executive board of the Aeronautics Branch which formulates all policies affecting the plans and activities of the branch.

The functions of the three principal agencies of the Aeronautics Branch follow.

AIR REGULATION SERVICE

The air regulation service of the Department of Commerce endeavors to protect the flying public and the aeronautic industry by eliminating as far as possible insufficiently trained pilots and unair-

worthy aircraft. The air commerce act of 1926 charges the Secretary of Commerce not only with the promotion of civil aeronautics but also with its regulation.

The fundamental principle of the act, however, is to afford the aeronautic industry every possible opportunity to regulate itself. From the beginning, the industry has cooperated with the Federal Government. The regulatory functions of the Aeronautics Branch of the Department of Commerce are coordinated under the director of air regulation. Under his direction are three main divisions: The inspection service, the licensing division, and the engine-testing section.

INSPECTION SERVICE

The inspection service activities and the variety of the phases of field work in connection therewith have increased to the extent that this service now constitutes one of the two divisions under the director of air regulation. Under his direction it is responsible for the entire field program of testing, inspection, and approval for license of commercial aircraft; the examination and approval for license of airmen; the inspection and approval of schools and repair stations; the investigation of civil aircraft accidents; and the field enforcement of the Air Commerce Regulations and the Air Traffic Rules. More specifically it is charged with the following duties:

Inspection and testing of airplanes for approved type certificate, inspection and testing of gliders for approved type certificate, inspection of aircraft repair stations for approved repair station certificate, inspection of civilian flying schools for approved school certificate, inspection of airplanes and gliders for license and renewal of license, inspection of repairs made to damaged aircraft, inspection of factories building approved-type aircraft, examination and flight testing of pilots for license, examination and flight testing of pilots for flying instructors ratings, flight testing of pilots for passenger carrying ratings in various classes and weights of aircraft, examination of ground school instructors for license, examination of mechanics for license, field investigation of accidents in civil aeronautics, investigation of reported violations of the regulations, field enforcement of the Air Commerce Regulations and the Air Traffic Rules.

Inspectors employed to carry out the foregoing duties are of two general classes: (1) Pilots of unusual qualifications who, on account of the nature of their work, must have not only expert flying ability and a thorough knowledge of airplanes and airplane construction but also sufficient tact and diplomacy properly to meet the public and carry out the work of examining pilots and mechanics and of inspecting aircraft in the field. Inspectors in this class who have other special qualifications, such as executive ability or a knowledge of engineering or flight training, are selected to fill the positions of supervisors, aeronautical engineering inspectors, and aeronautical school inspectors. (2) Airplane inspectors stationed in the various aircraft factories are selected for their intimate knowledge of structural details in the manufacture of aircraft and need not be pilots.

The pilot inspectors are subdivided into four classes: Supervising aeronautical inspectors, aeronautical engineering inspectors, aeronautical school inspectors, and aeronautical inspectors.

At the close of the fiscal year, the inspection service had in its employ a total of 90 inspectors, 75 of whom were (pilot) aeronautical inspectors and 15 (factory) airplane inspectors. Owing to limited appropriations for the fiscal year of 1931, the service was faced with the necessity of dispensing with 6 aeronautical and airplane inspectors so that the total at the beginning of the ensuing fiscal year will be 84 inspectors. While this total is greater than the figure shown in the annual report for 1929, the amount of work accomplished has increased to a much greater extent than the number of men employed.

The inspection service is current with its work regarding the handling of all types of applications. It has been necessary constantly to improve methods of operation, by accelerating action on applications, and by increasing the efficiency of examination and test procedure. Part of this has been possible through the delegation of more authority to the district supervisors.

The results of the changes in connection with the issuance and renewal of pilots' licenses which became effective during the past year have been thoroughly gratifying. The rating of pilots for passenger-carrying privileges according to weights and types of aircraft has raised the standard of flying ability among pilots of these classes with the consequent increase in safety to the flying public who ride as passengers.

The flying-school regulations, which became effective just before the beginning of the last fiscal year, have brought satisfactory development in this field. Forty-four schools have been issued approved school certificates during the year, and the graduates of these schools have shown a marked improvement in ability over those trained by unapproved methods.

The development in aircraft design and performance has also advanced substantially during the past year, owing in part at least to the critical testing of the various models by the engineering inspectors.

The efficiency of the inspection service could be further increased by the use of more airplanes. There are now more than three inspectors for each airplane, and the result is that the majority of travel must necessarily be by rail, thus greatly retarding the work of inspection. Obviously, the bulk of the inspectors' work is located at the various airports. This necessitates not only rail transportation but other means of travel from the rail terminals to the airports.

TABLE 1.—*Applications, inspections, and examinations, fiscal year 1930, compared with 1929*

Item	1930	1929
Applications for—		
Approved-type certificate (airplanes)	304	186
Approved-type certificate (gliders)	2	0
Approved school certificate	118	0
Approved repair station certificate	21	0
Airplane license (original)	7,385	4,740
Airplane license (renewal)	2,218	727
Glider license	5	0
Glider pilot's license	44	0
Mechanic's license	4,943	4,083

TABLE 1.—*Applications, inspections, and examinations, fiscal year 1930, compared with 1929*—Continued

Item	1930	1929
Applications for—Continued.		
Pilot's license	12,089	6,822
Pilot's passenger-carrying ratings (estimated)[1]	10,902	0
Flying instructor's rating	272	0
Ground instructor's license	353	0
Inspection of repairs after accident which required submission of engineering data	232	0
Accidents investigated and reported	689	456
Violations investigated and reported	612	503
Total	40,189	17,517

[1] The pilots' ratings were estimated as one and one-half times the number of active transport and limited commercial pilots who require at least 1 rating to maintain the status of their licenses. Many pilots have several ratings, each of which required a test flight with an inspector before issuance.

LICENSING DIVISION

The licensing division is responsible for the preparation and issuance of all aircraft, pilot's and mechanic's licenses and their renewals; for the transfer of title to aircraft assigned Department of Commerce numbers; for the issuance of certificates of airworthiness for export of aircraft to be exported to foreign countries having reciprocal agreements with the United States; for the validation of such certificates and the maintenance of all files and records pertaining to the foregoing; for determining whether aircraft which are to be made eligible for license are of proper structural design; for examining pilots and student pilots as to their physical and mental fitness for flying before they are licensed, checking by periodic examination of those who are already licensed; for handling the technical phases of enforcing the air commerce regulations, as well as the investigation of violations of the air commerce act of 1926, the Air Commerce Regulations, and the Air Traffic Rules, for the assessment of penalties, and for acting in a general advisory capacity in all matters pertaining to air law; and for determining the causes of all civil aircraft accidents.

This division is divided into five units, as follows: Medical section, registration section, enforcement section, accident board, and engineering section.

MEDICAL SECTION

The work of the medical section during the past fiscal year has been approximately 50 per cent greater than during the previous year. The number of physical examinations certified increased from 28,478 in the fiscal year 1929, to 43,902 in the fiscal year 1930. Comparative figures for the two years follow:

	1929	1930
Original examinations, trained pilots	3,709	2,701
Reexaminations, all classes	8,013	18,595
Student pilots, original examinations	16,756	22,606
Total	28,478	43,902

From the figure showing 2,701 original examinations for trained pilots in 1930 it would appear that the number of trained pilots is growing less. The opposite is the case, however. Practically all those who received training other than as licensed students have been provided for. The trained-pilot class now comes from the student class. Inasmuch as their student examinations are their original examinations, their numbers do not appear under "trained pilots, original examinations" but under "students." Their first examinations as trained pilots, therefore, appear under "reexaminations." It will be seen that the number of examinations under this heading of original examinations is rapidly decreasing, and should eventually reach zero.

While the number of students is much greater for the past fiscal year than for the previous one, the number of students has been less during the past six months than during the same period a year ago. In the first six months of 1929 there were 9,477 students while in the same period in 1930 there were 8,067. However, during May and June of 1930, there were more students examined than during the same months a year ago.

In addition to the 44,000 examinations received, 532 have been rechecked and certified for a higher grade on the basis of the same examinations.

Contact has been made with the inspection service on more than 100 doubtful cases to determine the advisability of granting waivers. Inasmuch as all the old-time pilots long since have been taken care of, the policy has been not to grant waivers as freely as has been done heretofore. The wisdom of a more stringent policy has been corroborated by the statistical work previously reported.

A summary of this statistical work shows clearly that a student's ability to learn to fly decreases directly as his deviations from the physical normal become greater. If he has disqualifying defects his chances of progressing to even a private license are so low as to be unworthy of consideration.

In the licensed pilot group, the accident rate, the number of pilots having accidents, and the fatality rate are all far higher in the group that shows deviations from the physically normal.

The number of medical examiners increased from 704 on June 30, 1929, to 816 on June 30, 1930. Medical examiners have been given authority to issue student permits direct. While the new student procedure and the new method of field renewal of licenses have relieved the department of much work in the Washington office, they have not relieved the medical section to any extent.

Physical qualifications for glider pilots and lighter-than-air pilots have been adopted during the past year.

A thorough revision has been made of Physical Standards for Airplane Pilots and the Supplementary Guide for Medical Examiners. Both have been incorporated into one pamphlet, and it is now in press.

The medical director attended the third annual meeting of the Pan-American Medical Association at Panama City, Panama. Steps were taken at that meeting to obtain further medical examiners in Central and South America and the West Indies.

There are now extraterritorial examiners in Alaska, Hawaii, Philippines, Panama, Cuba, Mexico, Peru, Brazil, and Trinidad. Ap-

pointments will be made shortly in Guatemala and other points in South America. Arrangements have been made to accept the military examinations of Argentina and Chile.

REGISTRATION SECTION

The volume of work of the registration section increased 53 per cent during the past fiscal year. This increase was due primarily to a natural growth in incoming applications for the various classes and types of licenses.

At present Canada and Colombia are the only foreign countries with which the United States has reciprocal agreements whereby aircraft may be imported and exported for commercial operation. However, during the year a new policy with reference to issuance of certificates of airworthiness for export was effected with a view to assisting manufacturers in the sale of approved-type aircraft in any foreign country whether or not a reciprocal agreement was in effect with such country. Manufacturers have indicated that this procedure has been of material assistance both in the sale and the licensing of aircraft in the country to which exported. Certificates of airworthiness for export were issued to a total of 129 aircraft exported to all countries, an increase of 18 per cent over the previous year. More than 90 per cent of the aircraft exported under these certificates were delivered to Canada.

TABLE 2.—*United States exports of aeronautical products, calendar years 1922–1930*

Item	Number	Value	Item	Number	Value
1922:			1927:		
Planes	37	$156,630	Planes	63	$848,568
Engines	147	72,819	Engines	84	484,875
Parts for planes		265,481	Parts for planes		570,117
Total value		494,930	Total value		1,903,583
1923:			1928:		
Planes	48	309,051	Planes	162	1,759,653
Engines	80	65,558	Engines	179	664,826
Parts for planes		58,949	Parts for planes		1,240,244
Total value		433,558	Total value		3,664,723
1924:			1929:		
Planes	59	112,738	Planes	354	5,574,480
Engines	146	219,609	Engines	321	1,375,697
Parts for planes		165,926	Parts for planes		2,252,203
Total value		798,273	Total value		9,202,380
1925:			1930 (first half):		
Planes	80	511,282	Planes	186	2,811,482
Engines	73	170,793	Engines	183	832,784
Parts for planes		101,584	Parts for planes		1,035,354
Total value		783,659	Total value		4,679,620
1926:					
Planes	50	303,149			
Engines	297	573,732			
Parts for planes		150,329			
Total value		1,027,210			

During the fiscal year, a total of 66,097 licenses, license renewals, title transfers, and export certificates was issued as against a total of 42,408 for the previous year. The renewal of licenses and the transfer of titles now constitute a major portion of the total work of the section. This work, entirely additional to the original issuance of licenses, has grown to where it now constitutes 42 per cent of the total volume of work. Table 3 shows the steadily increasing rate at which applications have been received and the constantly increasing volume of work necessitated by license renewals and the transferring of title to aircraft formally assigned Department of Commerce license numbers.

TABLE 3.—*Total applications received and licenses and certificates issued*

Item	1927	1928		1929		1930		Grand total
	Number	Number	Increase over previous fiscal year	Number	Increase over previous fiscal year	Number	Increase over previous fiscal year	
Aircraft:								
License applications received	1,123	3,422	*Per cent* 205	4,740	*Per cent* 39	7,385	*Per cent* 56	16,670
Licenses issued	147	1,728	1,075	4,379	153	6,531	49	12,785
Licenses renewed				727		2,278	213	3,005
Identification applications received	288	1,331	362	3,328	150	3,460	4	8,407
Identifications issued	237	1,328	460	3,256	145	3,370	4	8,191
Export certificates issued		65		109	68	129	18	303
Transfer title recorded		2,039		4,906	141	6,894	41	13,839
Pilots:[1]								
Applications received	1,812	3,488	92	6,822	96	12,089	77	24,211
Licenses issued	112	2,632	2,250	5,137	95	10,360	102	18,241
Licenses renewed		808		4,687	480	9,367	100	14,862
Student pilot permits issued		2,682		15,868	491	21,191	34	39,741
Glider pilot applications received						44		44
Glider pilots licensed						39		39
Mechanics:[2]								
Applications received	1,626	2,919	80	4,083	40	4,943	21	13,571
Licenses issued	99	2,806	2,734	3,264	16	3,719	14	9,888
Licenses renewed				75		2,219	2,859	2,294
Total	5,444	25,248	364	61,381	143	94,018	53	186,091

[1] Private, limited commercial, industrial, and transport.
[2] Airplane and engine.

Much difficulty has been experienced in keeping current the issuance of licenses, license renewals, and transfers of title. Whereas the volume of work has increased 3,332 per cent over July 1, 1927, it has only been possible to increase the registration personnel 400 per cent.

During the year an additional volume of work was necessitated by rewriting all classes of pilot licenses in accordance with the procedure of renewing these licenses in the field. Out of the 12,800 active licenses outstanding, approximately 3,000 licenses were rewritten prior to expiration, and the remainder were taken care of upon expiration. This work will not reoccur until five years hence.

With the renewal of pilot licenses in the field it was thought that the work of this section would be materially reduced. However, this reduction has not materialized owing to the fact that renewals

have increased 100 per cent over the fiscal year 1929 and, therefore, office procedure increased accordingly.

In an effort to eliminate confusion surrounding the procedure for transferring title to airplanes assigned Department of Commerce numbers an entirely new system of transfer of title has been devised.

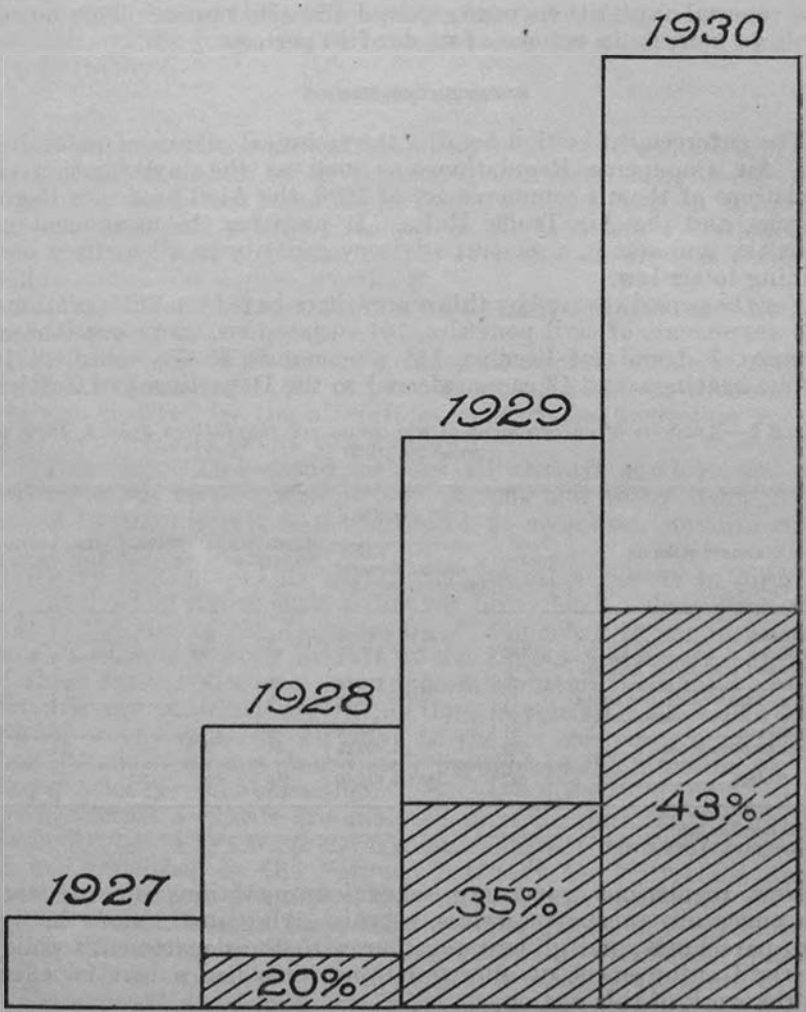


FIGURE 2.—Relation of license renewals and transfers of title to all applications received. (Shading represents license renewals and transfers of title)

A record, transfer, and reassignment form is being mailed to the owners of aircraft along with the license or identification mark. This form is self-explanatory and when properly completed and returned to the Department of Commerce, constitutes sufficient evidence of sale to support transfer of title to a new owner.

A system has been developed whereby aircraft may be registered in the names of purchasers who have financed their purchase through

credit agencies. So far the system has worked out satisfactorily to all concerned.

Although a marked saving has been effected through improved office routine and the utilization of modern equipment, the volume of work has continued to grow faster than the personnel could handle it with promptness. A résumé of the work shows that 66,000 original and renewal applications were received and acted upon. This represents an increase in volume of work of 60 per cent.

ENFORCEMENT SECTION

The enforcement section handles the technical phases of enforcing the Air Commerce Regulations, as well as the investigation of violations of the air commerce act of 1926, the Air Commerce Regulations, and the Air Traffic Rules. It prepares the assessment of penalties and acts in a general advisory capacity in all matters pertaining to air law.

For the period covered by this report there have been 612 violations, 183 assessments of civil penalties, 164 suspensions, 22 revocations of licenses, 7 denials of licenses, 148 reprimands, $3,675 collected, 10 public hearings, and 13 cases referred to the Department of Justice.

TABLE 4.—*Analysis of enforcement of air commerce regulations July 1, 1929, to June 30, 1930*

Nature of violation	Total number	Civil penalties		Reprimands	Suspensions	Revocations	Denials	Dismissals
		Number assessed	Amount collected					
Acrobatics	106	42	$862.50	16	36	3		9
Low flying	133	19	475.00	40	32	1		41
Unlicensed pilot flying licensed plane	79	42	762.50	26	6		4	1
Flying without navigation lights	13	3	50.00	6	1			3
Flying without identification numbers	11	5	125.00	6				
Miscellaneous offenses	270	72	1,400.00	54	89	18	3	34
Total	612	183	3,675.00	148	164	22	7	88

Public hearings held	10
Cases referred to Department of Justice	13

New regulations governing scheduled operations of interstate passenger air-transport services, schools giving instructions in flying, parachutes, and gliders, together with the department's policy of rigid enforcement of all regulations, have had a marked effect on the work of this section.

The section collaborates extensively in the preparation of State aeronautical legislation. Much effort is also devoted to coordination work, involving interpretations of the regulations in States and municipalities where the Federal regulations have been adopted and are being enforced by local authorities.

The year has introduced a number of new problems in connection with the operation of airports, such as matters of securing the removal or marking of obstructions and conflicts between owners of adjoining land and airport officials. In past years this type of difficulty was seldom encountered, but with the present develop-

ments of the industry problems of this nature are continually arising.

The section has made a compilation of State aeronautical legislation, and every effort is exerted to keep current information on State aeronautical legislation, since requests for it are constantly received. The section also strives to secure advance copies of all proposed legislation both State and municipal. These are carefully studied and the proponents of the measures are advised if changes are desirable.

ACCIDENT BOARD

The purpose of the aircraft accident board is to analyse and determine the causes of all civil aircraft accidents. The board consists of at least two experienced pilots, a flight surgeon, an aeronautical engineer, a lawyer versed in air law, and a statistician, thus assuring that any contributing factor to an aircraft accident will be covered by expert knowledge.

For statistical purposes, reports on aircraft accidents are divided into three classes as follows:

(1) *Accidents.*—This group includes all aircraft accidents involving death or serious injury to persons and all accidents wherein the damage incurred by the aircraft is sufficient to necessitate an inspection of repairs before being reflown.

(2) *Mishap.*—This group includes all aircraft accidents not involving death or serious injury to persons and where damage incurred by the aircraft is not sufficient to necessitate an inspection of repairs before being reflown.

(3) *No accident.*—This group includes all accidents to aircraft not incurred in flight, such as hangar fires, floods, windstorms, etc.

It is the aim of the Department of Commerce to secure reports on all accidents to civil aircraft of the United States. If a review of these reports discloses any apparent structural weakness of the aircraft, any incompetency in piloting, any irregularities of registration or any apparent violation of the air commerce regulations, such delinquencies are immediately brought to the attention of the proper office for suitable action.

All aircraft accidents are analyzed in strict conformity with the method outlined by the special committee on aircraft accident analysis and published by the National Advisory Committee for Aeronautics in Report No. 357. This method was developed by the special committee as a basis for the classification and comparison of aircraft accidents which would conform to a standard and be universally comparable for both civil and military accidents.

The aircraft accident report form has been carefully revised to meet the various changes in operating conditions and to secure statistical information. In addition to the aircraft accident report, a system has been developed whereby the Department of Commerce inspectors submit preliminary reports on all accidents occurring in their respective territories. This preliminary report provides sufficient information for the immediate suspension of a license where damage incurred by the aircraft is of sufficient magnitude to render its operation unsafe.

Facts brought out by accident analysis continue to play an important part in the constant development of safer aircraft and more

competent pilots, and constitute a useful and valuable check on the effectiveness of the air commerce regulations.

ENGINEERING SECTION

The primary function of the engineering section is to determine whether aircraft which are to be made eligible for license are of proper structural design. The fulfillment of this function necessitates a detailed examination of the structural strength of new and repaired aircraft, as well as an investigation of the suitability and airworthiness of the various component parts and accessories which are used in aircraft. These parts and accessories include propellers, engines, arrangement of power-plant installations, pontoons, wheels, and various patented devices which may be applied to aircraft.

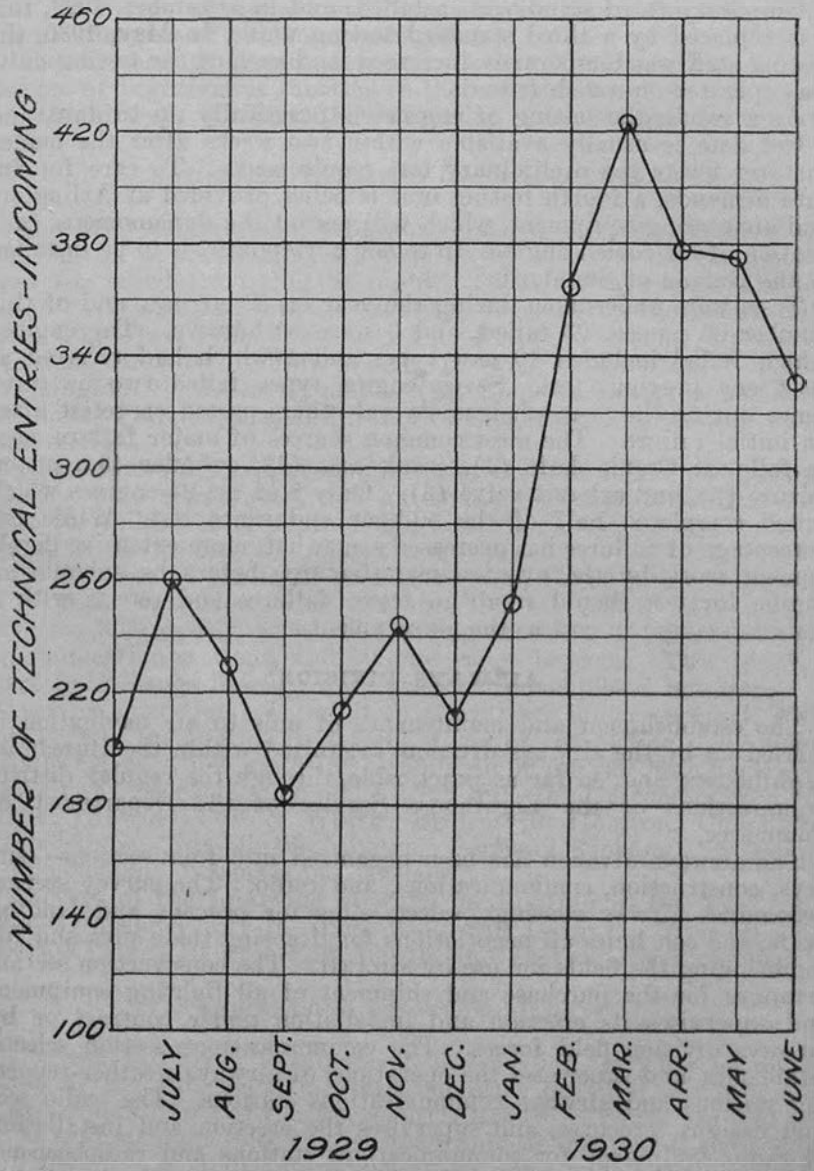
What is known as an approved-type certificate is issued to aircraft manufacturers meeting certain stipulated requirements. This entitles the manufacturer to build aircraft in exact accordance with an approved model; such aircraft are then eligible for commercial license. In order to obtain an approved-type certificate, the manufacturer must first submit complete technical data, together with stress analyses and blue prints of his aircraft. These plans are carefully checked for required strength and adherence to accepted engineering practice. This requires the attention of aeronautical engineers who are familiar with all the mathematical processes of aircraft analysis and design and technicians who are authorities on all the structural details and types of construction that can be applied to aircraft.

During the past fiscal year 164 approved-type certificates were granted to airplanes; 29 approved-type certificates were granted for engines; and 146 approved-type certificates were granted for propellers. In addition 140 different types of airplanes were examined and approved for license without being granted an approved-type certificate; 232 cases of repairs to damaged aircraft were investigated; 67 sets of drawings were examined and sealed for approved repair stations; and a large number of miscellaneous parts, such as pontoons, patented nuts, flexible hose connections, etc., were investigated. The total number of approvals granted to airplanes, engines, and propellers during the fiscal year amounted to 479. This is almost twice the number of approvals granted during the previous year, and is more than six and one-half times the number granted the year before that. In addition to these there were a large number of revisions to existing approvals, which were duly considered and acted upon.

The volume of incoming work is increasing steadily and shows no signs of diminishing. (See fig. 3.) Although the number of new-type airplanes being produced decreased during the latter part of the year, the number of repairs, alterations, and special modifications affecting those in service, increases steadily. A total of 3,465 technical subjects were considered during the year as compared to 1,140 during the previous year.

ENGINE-TESTING SECTION

The testing of commercial engine types to determine their suitability for use in licensed aircraft has been carried on at the Arlington



VOLUME OF INCOMING WORK FOR FISCAL YEAR 1929-30
(ENGINEERING)

FIGURE 3

engine-testing laboratory where two torque-stand testing units have been in continuous operation throughout the year. In August, 1929, a temporary third stand was installed, and in December, 1929, this was replaced by a third standard testing unit. In May, 1930, the testing staff was temporarily increased, and each of the testing units was operated on a 2-shift basis.

As a result, the testing of engines is practically up to date, and a test date is usually available within two weeks after the manufacturer meets the preliminary test requirements. To care for future demands, a fourth testing unit is being provided at Arlington, and air-cooling equipment, which will permit the dynamometer calibration of air-cooled engines up to 400 horsepower, is to be installed at the Bureau of Standards.

Tests were undertaken during the year on 52 engines, and of this number 26 passed, 23 failed, and 3 were withdrawn. The engines which failed included 10 new types and 4 which had received at least one previous test. Seven engine types failed two or three times during the year whereas several others passed on retest after an initial failure. The most common sources of major failure were as follows: Crank shaft (4), crank case (4), cylinder (3), piston seizure (3), and exhaust valve (3). Only 8 of the 23 engines which failed completed half of the 50-hour endurance test. While the percentage of failures has decreased somewhat, more extensive development work by the average manufacturer before he submits an engine for test should result in fewer failures and retests with a material saving in cost to the Government.

AIRWAYS DIVISION

The establishment and maintenance of aids to air navigation is carried on by the airways division, organized within the Bureau of Lighthouses, and, so far as practicable, through the regular district organizations of the Lighthouse Service of the Department of Commerce.

The airways division has been organized into four sections—surveys, construction, communications, and radio. The survey section determines airway routings, selects sites for beacons and landing fields, and concludes all negotiations for licensing these sites and for conditioning the fields for use by aircraft. The construction section arranges for the purchase and shipment of all lighting equipment and supervises its erection and installation under contract or by airways division field forces. The communications section selects, establishes, and supervises the operations of airways weather-reporting stations and airways communications stations. The radio section designs, procures, and supervises the erection and installation of radio equipment for communications stations and radiobeacons.

Maintenance of the intermediate landing fields and beacon lights is accomplished mainly by the district organizations of the Bureau of Lighthouses to which have been added the necessary special personnel.

Only two maintenance organizations, in addition to the regular lighthouse districts, have been required to maintain efficiently the airways extending from the Mississippi and Missouri River Valleys

to the eastern borders of California, Oregon, and Washington. These have been located at Salt Lake City, Utah, and Fort Worth, Tex., in charge of airways engineers and are concerned solely with the maintenance of aids to air navigation.

The divisions of finance, law and property, and personnel of the Bureau of Lighthouses function in their respective spheres of action for the airways division, thus obviating the necessity for special units.

NAVIGATION FACILITIES ON CIVIL AIRWAYS

The 1930 construction program included the establishment of lighting on approximately 3,100 miles of airways, all extensively used for scheduled flying at night. These airways were: Miami-Atlanta (Miami-Jacksonville section), Washington-Cleveland, Salt Lake City-Great Falls (Salt Lake City-Pocatello section), Portland-Spokane, Brownsville-Fort Worth, Brownsville-Houston, Norfolk-Washington, St. Louis-Columbus (St. Louis-Indianapolis section), Columbus-Philadelphia, and San Francisco-Seattle (Redding-Portland section).

Thirteen airways radio communication stations and 26 radio range beacons were constructed, and automatic telegraph-typewriter circuits for collection of weather and aircraft movement reports were placed in service on 5,650 miles of airways.

At the close of the fiscal year there were 13,500 miles of lighted airways in operation, with 319 intermediate fields, 1,477 airway beacons, 303 airway weather-reporting stations, 35 airways radio communication stations, and 9 radio range beacons. Twenty-seven more radio range beacons were practically completed but were not in service operation. In addition there were under contract, with the work of installation in various stages of completion, 1,728 miles of airways on which are being established 36 intermediate fields and 223 airway beacon lights. The 1,728 miles under construction include: Brownsville-Fort Worth, Brownsville-Houston, Columbus-Philadelphia, Norfolk-Washington, Portland-Spokane, St. Louis-Columbus, and Washington-Cleveland.

Surveys of the following airways for lighting in the fiscal year 1931 were under way in June, 1930: San Diego-Los Angeles, San Diego-El Paso, El Paso-Fort Worth, and Jacksonville-Richmond.

ENGINEERING LAYOUT OF AIRWAYS

Between the given terminals or intermediate airports as designated by the Interdepartmental Committee on Civil Airways and the executive board of the Aeronautics Branch, airways are laid out on as near straight lines as the topographical features of the region will permit. A strip approximately 25 miles wide throughout the length of the route is subjected to a careful scrutiny from the air to determine the location of the best flying country, the principal roads, railroads, centers of habitation, and other natural aids to flying or to the maintenance of beacons and landing fields. These studies are supplemented by a ground survey for corroboration of and additions to the data obtained from the air survey; and the route which offers the most advantageous combination of directness, good flying

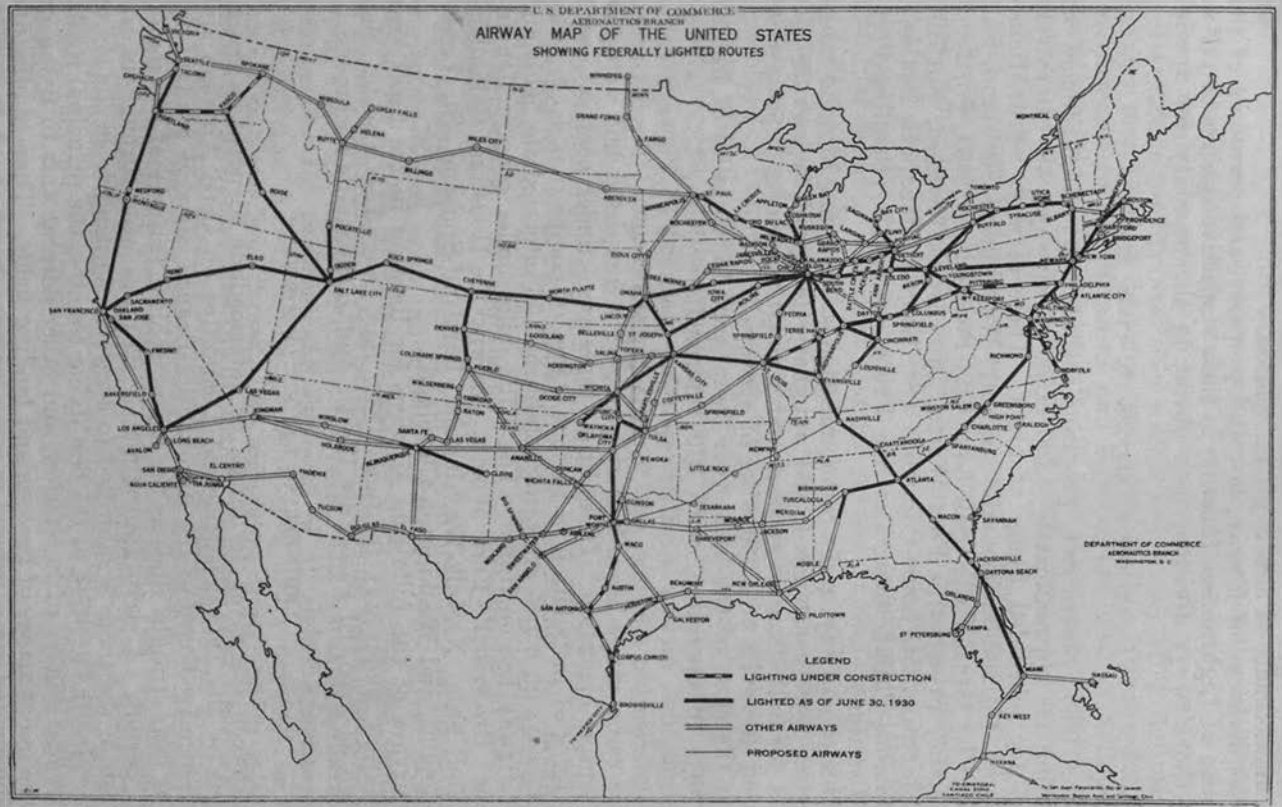

U. S. DEPARTMENT OF COMMERCE
AERONAUTICS BRANCH
AIRWAY MAP OF THE UNITED STATES
SHOWING FEDERALLY LIGHTED ROUTES
LEGEND
LIGHTING UNDER CONSTRUCTION
LIGHTED AS OF JUNE 30, 1930
OTHER AIRWAYS
PROPOSED AIRWAYS
DEPARTMENT OF COMMERCE
AERONAUTICS BRANCH

FIGURE 4

terrain, and proper maintenance facilities, is recommended to the consideration of the executive board of the Aeronautics Branch.

At this time the layout of radio range beacons to furnish radio direction is planned, and such revisions of the recommended route as may be found necessary for suitable location of radiobeacons is determined. Following approval by the executive board of the route as recommended or revised, the intermediate landing fields are tentatively selected and surveyed, and their recommended location reported to the executive board for approval.

The practice has been to select landing fields at intervals of 30 miles, directly on the airway center line if possible, and at least within the equisignal zone of the radiobeacon. This practice is likely to be modified in the future to conform with the requirements for a certificate of authority to operate scheduled interstate passenger air-transport service. These requirements include provisions that there shall be fields of sufficient size and at intervals not exceeding 50 miles for landing and taking off the largest commercial aircraft.

In many parts of the country it will be practicable to use 50-mile spacings for intermediate fields, but in the rougher territory and in sections subject to frequent poor-visibility conditions, fields located at closer intervals may be found necessary.

After approval by the executive board, specific field locations are licensed and beacon light sites between fields are selected. The standard spacing of beacon lights has been 10 miles; but, in accordance with the regulations governing the operation of scheduled interstate passenger air-transport services, and in view of the proposed use of the more powerful 36-inch beacon lights in place of the standard 24-inch searchlight, the standard spacing will be increased to 15 miles in the better flying regions.

Beacon light sites vary slightly from standard line and spacing in order to secure advantages of roadside location and commercial electric power, and also to secure for the sites the advantage of as high an elevation as practical, so that intervening ground elevations may not block the view from one beacon to the next. When the topography is such that this is impossible, elevations between adjacent regular beacons are marked with auxiliary beacons or blinkers of lower candlepower, so that light-to-light vision may always be maintained unless atmospheric conditions prevent.

Airways are designated by the first letters of their terminal cities and read from south to north and west to east. Thus, O–C for Omaha to Chicago, LA–SF for Los Angeles to San Francisco. All field and standard beacon sites are known by numbers which, by the addition of zero, indicate their approximate mileage on the airway. Thus, a field 32 miles from the starting point of an airway is No. 3; a beacon light 585 miles from the starting point is No. 58. Beacon lights other than standard are given numbers corresponding exactly to their mileage.

INTERMEDIATE LANDING FIELDS

Where landing fields and airports are nonexistent, and where safety demands the establishment of fields, the Department of Commerce establishes and maintains intermediate landing fields. The

intermediate landing fields are occupied by the Government under terms of a license providing for the right to carry out construction work incidental to the establishment, preparation, and operation of the fields; also the right of the aeronautical public to use the facilities with rights of ingress and egress and other privileges consistent with the purpose for which the intermediate fields are established.

The size of such intermediate landing fields, grades, surface conditions, crops, etc., are in accordance with the department's standard practice and are provided within available appropriations made by Congress for this purpose. The intermediate landing fields are boundary lighted, equipped with airway beacon lights and wind indicators, and otherwise marked for identification and usage by aircraft. The average cost of the lighting installation is approximately $5,000 per field.

The standard intermediate field in low altitude provides two landing strips or runways of a length of 2,000 feet and width of 600 feet, approximately at right angles to each other, with one strip lying in the direction of the prevailing wind. Such a field has an area of 47 acres. In the higher altitudes (above 4,000 feet) the standard length for landing strips is 2,500 to 3,000 feet. Landing strips may form a T, L, or + and the inner angles at the junctions of the strips are usually beveled off to provide additional diagonal landing space for use under conditions of strong cross winds. In many cases it is possible to secure triangular or square fields giving the desired runway lengths in all directions. In rough country it is often possible to secure only one landing strip, in which case an attempt is made to increase the width of such a 2-way field sufficiently to permit landing diagonally into strong cross winds.

Intermediate landing fields are licensed for occupation from year to year, with option for renewal for periods of 5 to 10 years, and for an indefinite period beyond this term subject to termination upon 6 months' notice by either party. Options for purchase by the Government within the period of the license are obtained when circumstances indicate that the field is likely to become a permanent and indispensable aid to air navigation.

The average rental cost of intermediate landing fields is $4.71 per acre per annum throughout the United States, but this includes an acreage in fields furnished at a nominal sum by municipalities and in fields established on public lands of the United States. Beacon light sites are similarly licensed, the average cost being $4.63 per site per annum.

Rules for the operation and usage of intermediate landing fields have been revised during the past year. Owing to the constantly increasing public interest in air transportation, the department has found it possible to establish many intermediate fields on a cooperative basis, whereby the city or town at which the field is located, or some civic or commercial organization of the city, rents or purchases the field and licenses it to the department at a reduced or nominal consideration, or conditions the field licensed directly from the owner by the department, or both. A large number of the intermediate landing fields established during the past year have been the result of cooperative arrangements, with considerable saving in expense to the Government. At the close of the fiscal year, 319 intermediate landing fields were being maintained by the airways division.

AIRWAY BEACON LIGHTS

Airway beacon lights have been established at approximately 10-mile intervals from airport to airport on all lighted airways. Every third beacon light is on an intermediate field, according to standard practice. Alterations of the direction of airway courses generally occur at fields, and the beacon lights between fields are established as near as possible on the air line from field to field.

The standard beacon light consists of a 1,000-watt searchlight fitted with a 24-inch precision parabolic mirror giving 1,000,000-beam candlepower. An electric motor of one-sixth horsepower rotates the searchlight at six revolutions per minute. Each beacon light is fitted with an automatic-lamp changer and two electric-lamp bulbs. In case one lamp burns out, the stand-by lamp is automatically placed in circuit and in focus within a fraction of a second.

Two course lights are mounted on the tower platform just below each searchlight, one pointing forward and one pointing backward on the airway course. The course lights are 500-watt searchlight projectors fitted with special cylindro-spherical mirrors and 18-inch doublet lenses, giving a beam of 15° horizontal and 8° vertical spread of 100,000-beam candlepower when fitted with aviation red or green lenses. Red lenses are used at beacon light sites and green lenses at intermediate landing fields. Each course light, in alternation (while the main beam of the beacon is swinging through the opposite 180° of arc) flashes its code signal, which corresponds to its number on the airway. Code signals run from 0 to 9. The pilot must know on which 100-mile section of airway he is flying in order to identify the site.

The beacon is mounted on a skeleton steel tower, the standard height of which is 51 feet. Towers of standard construction are, however, available in 20, 62, 75, and 87 foot heights for use where conditions indicate desirability of heights other than 51 feet. At the top of each tower is a 6-foot-square platform with guard railing, providing an opportunity for airway mechanicians to work on the lights with ease and safety.

A concrete directional arrow 54 feet in length, which points to the next higher-numbered beacon, is constructed on the ground at the base of the tower. The tower rises in the center of the arrow. On the chrome-yellow feather end of the arrow the beacon light site number is painted in black characters. At all fields and at beacon lights where local generating sets are required, a small power house, 10 by 14 feet, forms the feather end of the arrow. At fields which do not require local generators the houses provide storage facilities for emergency equipment.

Gasoline-engine driven electric-generating sets, where required, are furnished in duplicate, with thermostatic relay controls which will automatically start either generator if it becomes too cold during daylight hours and stop it when the temperature of the cooling water shall have risen to a predetermined value. This cycle is repeated, depending upon outside temperatures, so that starting of the plant at sunset is facilitated.

Astronomic electrically driven time clocks are installed at all beacon lights to switch on the commercial current or start the engine generator at sunset and switch off the current or generator at sunrise.

For use as auxiliary lights, or in lieu of standard beacon lights at standard spacings, the airways division has designed and installed other types of beacon lights which work effectively. Dioptric lanterns of 300 and 375 millimeters diameter have been used with single acetylene burners, with clusters of 3 acetylene burners, and with 500-watt electric lamps. Another standard unit is a double-ended range lantern fitted with two 18-inch doublet lenses similar to the course-light lenses, using a double acetylene burner light source.

In some cases wind-driven electric generators are used to furnish current for the light source. By utilizing the wind energy in this fashion it is possible to install full automatic clock-controlled beacon lights on points of extreme inaccessibility without the necessity of providing supplies of gasoline, oil, or acetylene gas. Such units require renewal of a small amount of lubricating oil and battery water but once in six months. When lesser units are used in place of standard beacon lights to mark the airway center line, the standard spacing is reduced to 3½ miles, by which arrangement the lower candlepower is offset by the shorter spacing, resulting in practically equivalent effectiveness.

There were 1,477 beacon lights of all types in operation at the close of the fiscal year.

TABLE 5.—*Scheduled airway operations for calendar year 1929*

Operator	Routes operated	Months operated	Miles flown	Passengers flown	Express (pounds)	Mail (pounds)	Mail payments
Atlantic Coast Airways.	New York-Atlantic City	1	4,010	193	0	0	0
Clifford Ball (Inc.).	Cleveland-Pittsburgh	12	166,077	62	1,786	97,027	$290,951.34
	Cleveland-Washington, D. C.	6	49,916	608	0	0	0
Boeing Air Transport.	San Francisco-Chicago	12	2,761,174	2,860	27,047	1,797,506	3,661,515.40
Brower's Air Service.	Wichita-Omaha	3	54,700	62	0	0	0
Colonial Airways Corporation:							
Canadian Colonial Airways.	New York-Montreal	12	219,570	964	4,717	(1)	(1)
Colonial Air Transport.	New York-Boston	12	237,143	4,796	1,300	116,095	348,238.74
Colonial Western Airways.	Cleveland-Albany	12	385,908	84	446	102,083	113,296.84
	Buffalo-Toronto	6	36,722	1,207	0	0	0
Capitol Airways.	Chicago-Indianapolis	6	13,050	102	300	0	0
	Indianapolis-Detroit	6	31,100	218	1,700	0	0
Continental Air Express (Inc.).	Los Angeles-Alameda	6	203,040	3,463	0	0	0
Curtiss Wright Flying Service.	Chicago municipal airport-Grant Park Ramp, Chicago.	3	963	0	0	19,328	1,245.00
Delta Air Service.	Dallas-Shreveport	6	27,985	30	0	0	0
	Shreveport-Monroe	6	14,356	22	0	0	0
	Monroe-Jackson	6	16,440	81	0	0	0
	Jackson-Meridian	4	8,064	12	0	0	0
	Meridian-Birmingham	4	12,768	15	0	0	0
Eastern Air Transport (Inc.).	New York-Atlanta	12	650,779	0	0	341,593	1,024,777.27
	Atlanta-Miami	12	514,043	0	0	121,333	177,125.09
Embry-Riddle	Cincinnati-Chicago	12	394,042	772	420	79,364	116,600.17
Ford Airways	Detroit-Chicago	12	120,935	0	800,134	0	0
	Detroit-Buffalo	12	121,570	0	809,302	0	0
Gorst Air Transport (Inc.).	Seattle-Bremerton	6	54,425	17,192	6,153	0	0
Interstate Airlines (Inc.).	Chicago-Atlanta	12	599,442	1,252	0	98,067	76,491.61
	Evansville-St. Louis	12	(2)	(2)	0	(2)	(2)

[1] Mail carried or revenue to contractor on individual foreign air-mail routes not available but the total pounds of mail carried and money paid these contractors is included in the totals of the "Mail (pounds)" and "Mail payments" columns.

[2] Included in total of operator.

TABLE 5.—*Scheduled airway operations for calendar year 1929*—Continued

Operator	Routes operated	Months operated	Miles flown	Passengers flown	Express (pounds)	Mail (pounds)	Mail payments
Kohler Aviation Corporation.	Grand Rapids-Milwaukee	4	46,077	371	0	0	0
Mamer Air Transport.	Spokane-Portland	9	82,375	575	0	0	0
	Portland-Seattle	1	4,800	204	0	0	0
Mason & Dixon Air Lines (Inc.).	Cincinnati-Detroit	4	56,380	708	246	0	0
Mid-Continent Air Express.	Denver-El Paso	3	108,676	329	0	0	0
	Denver-Kansas City	2	47,461	39	0	0	0
Middle States Air Lines (Inc.).	Akron-Detroit	3	25,740	209	0	0	0
	Akron-Pittsburgh	3	9,800	12	0	0	0
Midwest Airways Corporation.	Waterloo-Des Moines	6	26,200	346	0	0	0
National Air Transport (Inc.).	New York-Chicago	12	1,348,405	1	69,489	1,618,288	$1,350,444.10
	Chicago-Dallas	12	1,232,781	0	4,153	390,957	1,174,141.97
National Parks Airways (Inc.).	Salt Lake City-Great Falls	11	436,482	1,682	0	69,373	171,659.92
	Salt Lake City-Pocatello	6	57,440	59	0	0	0
Nevada Airlines (Inc.).	Los Angeles-Reno	5	135,802	443	0	0	0
	Reno-Las Vegas	2	13,505	35	0	0	0
New Orleans Air Line.	New Orleans-Pilottown	12	71,310	0	0	(1)	(1)
Northwest Airways (Inc.).	Chicago-Minneapolis	12	701,585	4,703	1,045	179,376	493,109.95
	Milwaukee-Green Bay	12	(2)	(2)	(2)	(2)	(2)
Pacific Air Transport.	Los Angeles-Seattle	12	812,596	3,224	2,695	253,437	721,456.22
	Oakland-San Jose	12	(2)	(2)	(2)	(2)	(2)
Pan American Airways.	Miami-Habana	12	239,996	4,619	0	(1)	(1)
	Miami-Nassau	7	45,787	556	0	(1)	(1)
	Miami-San Juan	12	441,677	2,596	0	(1)	(1)
	Miami-Cristobal	12	527,802	1,990	0	(1)	(1)
	San Juan-Paramaribo	3	41,095	25	0	(1)	(1)
	Cristobal-Curacao	6	54,868	23	0	(1)	(1)
	Brownsville-Mexico City	10	245,481	-------	0	(1)	(1)
Pan American Grace Airways (Inc.).	Cristobal-Guayaquil	6	57,781	0	0	(1)	(1)
	Guayaquil-Mollendo	6	111,828	1,036	2,647	(1)	(1)
	Mollendo-Santiago	5	51,928	0	0	(1)	(1)
	Santiago-Buenos Aires	3	17,568	0	0	(1)	(1)
	Buenos Aires-Montevideo	1	1,350	0	0	(1)	(1)
	Guatemala-San Salvador	5	374,360	0	0	0	0
Pickwick Airways (Inc.).	Los Angeles-San Francisco	3	47,520	620	0	0	0
	Los Angeles-San Diego	6	131,391	3,160	0	0	0
Pittsburgh Airways (Inc.).	Pittsburgh-Newark via Philadelphia.	2	3,500	30	0	0	0
Rapid Air Lines (Inc.).	Rapid City-Huron	2	48,000	16	40	0	0
Southwest Air Fast Express.	Tulsa-Dallas	9	151,980	2,506	0	0	0
	Tulsa-Sweetwater	7	143,250	3,637	0	0	0
	Tulsa-St. Louis	9	176,414	1,827	0	0	0
	Tulsa-Kansas City	9	114,102	1,661	0	0	0
	Tulsa-Oklahoma City	5	43,920	1,488	0	0	0
	Dallas-Wichita Falls	3	25,620	893	0	0	0
Seagull Airlines (Inc.).	Salt Lake City-Ely	4	18,860	85	322	0	0
Seattle Victoria Air Mail (Inc.).	Seattle-Victoria	12	21,248	11	445	(1)	(1)
Southern Air Transport Corporation:							
Gulf Airlines	New Orleans-Atlanta	12	339,352	19	0	86,610	151,516.01
	Houston-New Orleans	12	208,972	35	0	42,146	42,146.80
Texas Air Transport.	Dallas-Brownsville	12	540,635	1,485	0	83,671	241,763.96
	Dallas-Galveston	12	307,243	672	0	45,394	131,186.84
	Dallas-El Paso	6	207,268	901	0	0	0
Standard Airlines (Inc.).	Los Angeles-El Paso	11	507,892	3,549	1,980	0	0
Stout Air Service (Inc.).	Detroit-Cleveland	12	136,016	5,687	2,383	0	0
	Detroit-Chicago	12	197,453	3,954	18,603	0	0
T. A. T.-Maddux Air lines.	Columbus-Waynoka	6	267,144	1,535	0	0	0
	Los Angeles-Clovis	6	278,210	850	0	0	0
	Los Angeles-Agua Caliente	6	187,480	10,173	0	0	0
	Los Angeles-San Francisco	12	890,610	23,200	14,333	0	0
	Los Angeles-Phoenix	6	(2)	(2)	(2)	0	0

[1] Mail carried or revenue to contractor on individual foreign air-mail routes not available but the tota pounds of mail carried and money paid these contractors is included in the totals of the "Mail (pounds)" and "Mail payments" columns.
[2] Included in total of operator.

TABLE 5.—*Scheduled airway operations for calendar year 1929*—Continued

Operator	Routes operated	Months operated	Miles flown	Passengers flown	Express (pounds)	Mail (pounds)	Mail payments
Thompson Aeronautical Corporation.	Bay City-Chicago	12	462,409	442	0	173,232	$154,102.66
	Detroit-Cleveland	5	95,110	2,936	461	0	0
United States Air Transport.	Washington-New York	-----	(3)	(3)	(3)	0	0
United States Airways (Inc.).	Kansas City-Denver	5	56,667	515	0	0	0
Universal Aviation Corporation:							
Braniff Airlines Division.	Tulsa-Oklahoma City	12	288,905	7,086	0	0	0
	Oklahoma City-Dallas	12	91,390	1,009	0	0	0
	Oklahoma City - Wichita Falls.	3	27,375	517	0	0	0
	Wichita Falls-San Angelo	3	39,752	378	0	0	0
	Tulsa-Seminole	3	28,650	546	0	0	0
	Oklahoma City-Amarillo	3	11,280	76	0	0	0
Central Airlines Division.	Wichita-Kansas City	6	109,944	1,466	0	0	0
	Wichita-Tulsa	12	203,651	2,577	0	0	0
	Wichita-Oklahoma City	5	40,374	353	0	0	0
Continental Airlines Division.	Cleveland-Louisville	12	356,993	500	45,646	95,840	116,872.53
Northern Airlines Division.	Chicago-Minneapolis	[4] 4	9,800	95	0	0	0
	Chicago-Cleveland	[4] 12	153,276	2,345	0	0	0
	Chicago-Kansas City	7	147,518	1,051	0	0	0
	Kansas City-Garden City	7	68,217	357	10,140	0	0
Robertson Division.	St. Louis-Chicago	12	381,903	2,511	1,039	78,077	197,610.71
	St. Louis-Omaha	12	308,678	969	0	65,279	51,197.31
Varney Air Lines (Inc.).	Salt Lake City-Pasco	12	491,411	0	0	236,083	706,399.40
	Pasco-Seattle-Spokane	4	93,790	0	0	52,909	4,759.82
Wedell Williams Air Service (Inc.).	New Orleans-Shreveport	5	30,700	181	0	0	0
	New Orleans-St. Louis	5	24,200	82	0	0	0
	New Orleans-Grand Isle	1	2,200	203	0	0	0
West Coast Air Transport Corporation.	Seattle-San Francisco	12	276,152	3,955	171	0	0
Western Air Express (Inc.).	Los Angeles-Salt Lake City	12	760,405	1,300	21,687	757,685	2,272,976.80
	Los Angeles-San Francisco	12	388,841	5,018	747	0	0
	Los Angeles-Kansas City	12	619,529	2,324	1,017	0	0
	Pueblo-Cheyenne	12	166,685	161	42	98,828	82,027.69
	Los Angeles-Avalon	12	88,412	6,524	14,243	0	0
	Los Angeles-Agua Caliente	6	13,629	627	0	0	0
Wichita Falls	Wichita-Kansas City	6	44,625	1,140	0	0	0
Yellow Cab Airways.	Kansas City-Minneapolis	4	37,790	387	0	0	0
		-----	[5] 100,000	-----	-----	-----	-----
Canadian and Latin-American air mail (U. S. contract) [1] [6].		-----	-----	-----	-----	672,433	3,168,906.56
Total		-----	25,141,499	173,405	1,866,879	7,772,014	17,042,520.71

[1] Mail carried or revenue to contractor on individual foreign air-mail routes not available but the total pounds of mail carried and money paid these contractors is included in the totals of the "Mail (pounds)" and "Mail payments" columns.

[3] No report.

[4] Information for first 3 months not available.

[5] This item of 100,000 miles has been listed to make allowance for the fact that the Aeronautics Branch has been unable to secure reports from several air-transport companies that were operating at some time during the last 6 months of 1929.

[6] Does not include mail carried or revenue from mail carried under contract with other Governments.

WEATHER SERVICE AND COMMUNICATIONS

During the fiscal year, the United States Weather Bureau established pilot-balloon service at 8 additional stations, making a total of 53 stations of this type. The majority of these are located at airports and furnish information at frequent intervals during the day and night to collecting centers along the airways. Reports are also received from more than 200 first-order Weather Bureau stations twice daily. These, in combination with the upper-air reports, are utilized in making aviation forecasts which are transmitted through the medium of automatic telegraph-typewriter and radio communication stations to all pilots using the airways.

During the fiscal year the Weather Bureau established 120 special airways weather reporting stations in addition to the 110 already in operation.

Additional automatic telegraph-typewriter circuits have been established for weather-reporting service, comprising a system 5,650 miles in length with 120 stations.

Information as to weather conditions in the areas adjacent to an airway is of considerable value in forecasting changes to be expected directly on the airway within the ensuing 2 or 3 hours. For this purpose some 60 Weather Bureau stations have been established from 150 to 200 miles on either side of the transcontinental airway and approximately the same distance apart. Reports are being received from each of these stations at 4 principal collecting centers at 3-hour intervals, day and night. A résumé of conditions in the geographical area surrounding each collecting center and a short-range forecast are compiled by an official of the Weather Bureau and transmitted to all airways radio stations within the sector, for simultaneous broadcast. This service is to be extended to other areas during the fiscal year 1931. All meteorological stations along the frequently used airways are being rapidly provided with full-instrument equipment, including sounding balloons and ceiling lights.

Likewise the volume of radio and automatic telegraph-typewriter traffic on the airways communication system requires closer supervision and direction than can be given by the airways traffic supervisor at Washington. Accordingly the communications system has been divided administratively into seven districts, each under operating direction of an assistant airway traffic supervisor. Assistant airway traffic supervisors are at present stationed at the airways communication stations at Hadley Field, New Brunswick, N. J.; Cleveland, Omaha, Salt Lake City, Oakland, St. Louis, and Atlanta.

At the close of the fiscal year 238 licensed radio operators were on duty at the airways communication and radiobeacon stations.

RADIO EQUIPMENT

The standard type airways radio communication station comprises a 2-kilowatt radio telephone and telegraph transmitter with motor generator, line amplifier, and microphones, which operate on frequencies from 190 to 500 kilocycles and is used for broadcasting by voice to airplanes and for point-to-point communication with similar radio stations; a 400-watt crystal-controlled high-frequency radiotelegraph transmitter for point-to-point communication on frequencies from 3,000 to 6,000 kilocycles; an intermediate-frequency receiver 75 to 1,000 kilocycles; a high-frequency receiver 2,000 to 15,000 kilocycles; and, where required, emergency power equipment. The emergency power equipment consists of gasoline-engine-driven generating sets of three different sizes, depending upon requirements 2.3, 5, and 20 kilowatts. These are used for furnishing electrical current for radio transmission, station lights, and tower obstruction lights.

During the past year 15 standard stations were erected at the following locations: Washington, Richmond, Greensboro, N. C., Spartanburg, S. C., Atlanta, Boise, Pasco, Wash., Albany, N. Y., Buffalo, Boston, Tulsa, Fort Worth, Medford, and Portland, Oreg.,

and Seattle. Six of the foregoing stations replaced temporary stations that had previously been established at Fort Worth, Washington, D. C., Richmond, Greensboro, Spartanburg, and Atlanta. The temporary station at Oklahoma City is still in operation. These stations, with the exception of Oklahoma City, broadcast weather information on hourly schedules by radiotelephone to aircraft in flight along the airways. One temporary radio station was established at Murfreesboro, Tenn., to provide weather broadcasting service pending the establishment of standard installation.

At the close of the year 35 standard broadcasting stations were in operation at the following locations: Los Angeles, Fresno, and Oakland, Calif.; Medford and Portland, Oreg.; Seattle, Wash.; Reno and Elko, Nev.; Salt Lake City; Rock Springs and Cheyenne, Wyo.; North Platte and Omaha, Nebr.; Iowa City; Chicago; Bryan and Cleveland, Ohio; Bellefonte, Pa.; Hadley Field, New Brunswick, N. J.; Boise, Idaho; Pasco, Wash.; La Crosse, Wis.; Wichita, Kans.; Fort Worth, Tex.; Tulsa, Okla.; Kansas City and St. Louis, Mo.; Atlanta, Ga.; Spartanburg, S. C.; Greensboro, N. C.; Richmond, Va.; Washington, D. C.; Buffalo and Albany, N. Y.; Boston, Mass.; and Key West, Fla. A standard station at Buffalo was 90 per cent complete at the end of the fiscal year and will be placed in operation about October 1, 1930. In addition, temporary radio stations were in operation at Murfreesboro, Tenn., and Oklahoma City. Two auxiliary stations equipped with intermediate and high frequency transmitting and receiving equipment were in operation at Strevell, Idaho, and Pleasant Valley, Nev., where, because of remote location, no other form of communication is available.

On June 30, 27 aural-type radio range beacon stations were approximately 95 per cent complete, and it is expected that they will be placed in operation about September 1, 1930. At the beginning of the fiscal year seven aural-type radio range beacons were in operation at New Brunswick, N. J.; Bellefonte, Pa.; Cleveland; Goshen, Ind.; Sterling, Ill.; Des Moines, Iowa; and Key West, Fla. Two additional beacons were placed in operation at Boston and Chicago during the year.

Seven visual-type radiobeacons were constructed at the lighthouse depot at Detroit, Mich., and an experimental installation was made at Detroit. Experience with this installation indicated that the equipment as designed was suitable for the purpose intended; and a second visual beacon is in the process of installation by the airways division at Bellefonte, Pa., for practical service trials.

Radio marker beacons consisting of 7½-watt single and double frequency automatic transmitters, with an effective range of from 3 to 5 miles, were installed at Numidia and Brookville, Pa., Toledo and Bryan, Ohio; Lansing, Mich.; Cicero and Aurora, Ill.; and Iowa City, Iowa. In addition, an experimental installation was made at Vickery, Ohio, with a modified transmitter capable of being operated as a radiotelephone transmitter as well as a marker-beacon transmitter. Experience with this installation indicates the feasibility of utilizing the marker-beacon equipment for maintaining communication with radio-equipped aircraft passing over marker-beacon stations. A high-frequency receiver capable of receiving telephone signals on a frequency of 3,106 kilocycles is

added to this installation for reception of transmission from the plane.

In order to test the efficiency of operation of the radio equipment, two of the airways division airplanes carrying radio-receiving equipment have been in practically continuous use for this work, and valuable data have been obtained.

An agreement was effected with the War Department whereby certain frequencies heretofore allocated to the Bureau of Lighthouses were exchanged with certain War Department frequencies so that all the channels in the 250 to 285 kilocycles frequency band are available for use by the Department of Commerce for the broadcasting of weather information. This arrangement practically doubled the frequencies available for this work, and has improved the radio service through elimination of other station interference.

Cooperation with the manufacturers of radio equipment has resulted in the production of receiving sets capable of operating on these frequencies, so that standard aircraft receiving equipment now includes the frequency range from 230 to 460 kilocycles.

A conference with representatives of the Canadian Department of Marine and Fisheries was held in New York City to consider frequency assignments so as to eliminate interference between the airways radio service of the two countries. Representatives of the Aeronautics Branch, Federal Radio Commission, and State Department attended.

Experimental 2-way communication service between aircraft and ground stations was inaugurated on the Chicago-New York airway during the fiscal year. An air-transport company operating over this route equipped its planes with radiotelephone transmitters for communicating with airway radiotelephone stations along the route. Receiving stations were established, at points remote from the transmitter for this service, at Maywood, Ill., Cleveland, Ohio, and Hadley Field, New Brunswick, N. J. The purpose of this experimental service was to determine the practicability and utility of intercommunication between aircraft and ground, and to aid the air-transport operations in determining the type of equipment required for both ground and aircraft use.

MAINTENANCE OF AIRWAYS

Airways equipment, upon being installed by the airways division, is assigned to the Lighthouse Service district offices for maintenance. Airways mechanicians are assigned to patrol 175-mile sections. They are provided with ½ to 1¼ ton panel-body motor trucks, equipped with spare parts and tools for taking care of practically any service or emergency repair job required on any type of airway lighting equipment. Airway mechanicians make their rounds and check over each beacon light at least twice a month.

At landing fields remote from habitation and where hourly automatic telegraph-typewriter weather reports are furnished, airways keepers are on duty 24 hours daily. At other fields part-time caretakers are employed.

At the close of the fiscal year, 29 airways engineers, 95 airways mechanicians, and 955 keepers, caretakers, and attendants were employed in the maintenance of 13,504 miles of airways.

IMPROVEMENTS IN AIRWAYS LIGHTING EQUIPMENT

A 36-inch rotating beacon was designed primarily for use in the Southwest, where visibility is good and commercial current and caretakers are scarce. The new beacon employs a lens system in each end of a 36-inch drum with a single 1,000-watt incandescent lamp light source, projecting a high-power beam in excess of 1,000,000 candlepower from each end of the drum. Each optical system consists of an inner and outer prismatic lens, the outer lenses of each doublet being clear and the inner lenses clear or colored as desired. With a clear-lens system at one end and a colored-lens system at the other the beacon will show a clear and colored flash of high candlepower during each 10-second cycle. Heretofore colored flashes have been obtained through the addition of course lights employing 500-watt lamps as light sources. The new beacon will make possible a reduction in load of 500 watts on each site, without sacrifice to the color characteristics.

Other developments in airways lighting equipment brought about during the past fiscal year were:

Further improvement in the illumination of the standard wind cone through the use of a full parabolic reflector installed in the base of the cone; design of a new motor-driven sign flasher, utilizing cam-operated tilting mercury tubes for obtaining desired code flashes; installation of amber lenses on course lights at intermediate fields was discarded and green was adopted as the standard color; further improvements in the astronomic-dial time switch, and in the standard control cabinets; development of a ventilator system for the standard code beacon so that 500-watt lamps can be used as light sources without undue heating of the 300-millimeter Fresnel lenses (with this improvement the airways code beacon becomes a very satisfactory unit for airport use); use of a monoplane filament instead of the semicylindrical type used heretofore in the standard 1,000-watt, 110-volt, T–20 beacon lamp.

Service tests of 3 KVA, single-phase full automatic engine-generator sets for use at sites where commercial current is not available, and where distances between power plants and beacon lights require transmission of power at high voltages, have resulted in the adoption of this unit as standard for this type of installation, and its serious consideration for adoption as an automatic emergency power supply source at fields operated on commercial current.

TABLE 6.—*Aids to air navigation*

ESTABLISHED AND OPERATING JUNE 30, 1930

Airway	Miles lighted	Airports [1, 2]	Intermediate fields								Beacons				Weather stations [2]		Radio stations [2]			Telephone	Service trucks [4]
			Boundary lights			Obstruction lights		Acreage		Rent		24-inch revolving		Flashing		Automatic telegraph typewriter	Others	Communication	Radiobeacon [3]	Marker beacon	
			Number	Total	Per field	Total	Per field	Total	Per field	Total	Per acre	Number	Average rent	Number	Average rent						
Albuquerque-Wichita	305	7	3	116	38	23	7.7	832	277	$82.00	$0.099	23	$1.22	15	$1.33			1			4
Atlanta-Chicago	656	9	14	394	24.6	51	3.6	871.7	62.3	5,091.00	5.85	51	2.23	2	None.	2	15	3	1	2	1	4
Atlanta-New York	788	14	19	457	26.9	139	7.2	1,027.05	60.4	7,863.50	7.66	76	7.89	4	3.00	9	4	6	1		23	8
Brownsville-Fort Worth	210	7	2	56	28	19	9.5	154	77	1,256.00	8.15	8	3.19				3	1				1
Brownsville-Houston	120	2	4	119	30			371.2	92.8	1,877.00	1.58	12	1.33				2					
Chicago-New York	740	7	34	683	20	155	4.5	1,843.6	54.2	19,280.00	10.46	73	21.27	5	6.25	22	1	5	5	6	26	7
Chicago-Twin Cities	472	8	10	213	21.3	53	5.3	425.7	42.5	5,209.00	12.24	42	27.40	7	2.14		1	2			6	3
Chicago-Twin Cities cutoff	40																1					
Cincinnati-Chicago	274	5	6	151	25	12	6	322.00	53.66	4,710.00	14.62	25	4.84			3		1	1	2		2
Cleveland-Albany	459	10	10	220	22	71	7	543.18	54.3	2,006.00	3.69	38	4.58	2			8	3			4	2
Cleveland-Detroit	134	3	1	30	30	3	3	106.64	106.6	533.20	5.00	7	34.43			4		1	1	1		1
Dallas-Kansas City	545	7	13	265	20.4	84	6.5	665	51	4,230.00	6.36	48	12.71	30	6.33		9	4				4
Kansas City-Chicago	455	8	9	174	19.3	62	7	449.50	49.9	4,411.00	9.81	30	11.50	5	7.00		4	2	1	1	4	2
Kansas City-Omaha	158	3	3	81	27	14	4.7	142.65	47.5	1,426.50	10.00	11	2.09			4		2			2	1
Kansas City-St. Louis	228	4	6	184	30.7	32	5.3	410	68.3	1,704.00	4.15	21	1.52			5		2			4	2
Los Angeles-Albuquerque	34	1										3	2.00					1				1
Los Angeles-Salt Lake	670	5	23	548	23.8	27	1.1	3,971	172.6	2,637.50	.66	47	1.23	79	.40		22	2			1	8
Los Angeles-San Francisco	380	12	8	173	21.6	29	3.6	701.32	87.7	5,234.00	7.46	33	4.40	4	.25	13	19	3			2	3
Louisville-Cleveland	367	7	9	170	19	60	6.6	416.19	46.24	2,778.00	6.68	29	12.76			8	3	1	1		1	3
Miami-Atlanta	631	15	11	291	26.5	48	4.4	779.00	70.8	934.00	1.20	46	2.13	2	3.00		6	1				2
Michigan Airways	362	10	1	33	33	11	11	68.2	68	540.00	12.00	17	6.23			4	3					1
Milwaukee-Green Bay	63	5	1	27	27	5	5	45	45	1.00	.022	5	.80				1					1
New Orleans-Atlanta	226	2	7	162	23	49	7	302.14	43.1	2,175.00	7.20	21	8.57	5	3.40		2	1				3
New York-Boston	201	12	3	90	30	40	13	115	38.3	1,081.00	9.40	20	7.25	10	1.20	8		2	2		6	2
New York-Montreal	142	4	3	77	26.3	36	12	130	43	3.00	.02	12	5.17	2	10.00		5	2			4	1
Omaha-Chicago	431	10	10	211	21	61	6	476.8	47.7	5,480.00	11.49	36	7.53	26	9.46	8	3	3	2	3	6	7
Pueblo-Cheyenne	200	6	5	117	23	14	3	455.3	91	1,941.00	4.26	17	9.47	7	4.43		1	1			2	1
Salt Lake-Great Falls	150	7	4	134	33.5	14	3.5	456	114	1,223.31	2.68	14	6.21	4	4.00		11	1				1
Salt Lake-Omaha	943	11	25	599	24	41	1	2,410	96.4	8,097.62	3.36	78	5.41	23	.95	18	3	5			26	7

[1] All airports are established, maintained, and operated through public or private enterprise and not by the Federal Government.

[2] The totals for weather stations and radio stations, as shown, are not the totals of the figures given, as one unit frequently serves two or more airways and is listed two or more times.

[3] One radio communication station and one radiobeacon are located at Key West, Fla., providing service on the Key West-Habana Airway, which is not listed.

[4] The totals for service trucks as shown are not the totals of the figures listed, as there are spare service trucks not definitely assigned to specific airways.

TABLE 6.—*Aids to air navigation*—Continued

ESTABLISHED AND OPERATING JUNE 30, 1930—Continued

Airway	Miles lighted	Airports	Intermediate fields									Beacons				Weather stations		Radio stations				
			Number	Boundary lights		Obstruction lights		Acreage		Rent		24-inch revolving		Flashing		Automatic telegraph typewriter	Others	Communication	Radiobeacon	Marker beacon	Telephone	Service trucks
				Total	Per field	Total	Per field	Total	Per field	Total	Per acre	Number	Average rent	Number	Average rent							
Salt Lake-Pasco	560	4	14	334	24	66	4.7	1,303	93	$4,059.75	$3.11	51	$3.06	12	$2.00	----	8	3	----	----	9	2
San Francisco-Salt Lake	670	6	23	657	28.6	96	4	2,847.7	123.8	5,936.50	2.08	63	3.21	90	2.42	17	11	4	----	----	8	5
Battle Mountain-Parran cutoff	166																					
San Francisco-Seattle	762	19	17	373	22	92	5.4	844.2	50	7,583.00	8.99	70	6.55	13	5.60	15	17	4	----	----	1	7
St. Louis-Columbus	135	4	2	75	37.5	25	12.5	96	48	1,370.00	14.27	10	1.00	----	----	7	----	----	----	----	----	1
Portland-Spokane (Pasco-Spokane section)	134	2	4	106	26.5	6	1.5	166.72	41.7	203.00	4.86	13	1.27	----	----	----	9	2	----	----	----	3
St. Louis-Chicago	275	6	8	168	21	7	1	347.2	43.4	2,801.00	8.06	25	16.40	5	3.00	4	1	2	----	1	----	3
St. Louis-Evansville	162	2	4	117	29	13	3	264.5	66	1,551.00	5.86	15	2.13	----	----	----	1	1	----	----	----	2
Tulsa-Ponca City	76	2	2	52	26	5	2.5	129.25	64.6	370.00	2.86	2	------	19	.95	----	2	1	----	----	----	1
Washington-Cleveland (Pittsburgh-Cleveland)	135	10	1	33	33	4	4	35.5	35.5	1.00	.028	7	11.14	----	------	----	2	2	----	----	1	2
Total	13,459	----	319	7,690	24.1	1,467	4.59	24,554.24	77.21	115,679.88	4.71	1,099	5.28	378	2.73	120	178	35	9	7	131	107

UNDER CONSTRUCTION AS OF JUNE 30, 1930

Brownsville-Fort Worth (Kingsville-Waco section)	312	5	5	----	----	----	----	----	----	----	----	25	------	----	----	----	----	----	----	----	----	----
Brownsville-Houston (Kingsville-Houston section)	226	2	6	----	----	----	----	----	----	----	----	22	------	----	----	----	----	----	----	----	----	----
Columbus-Philadelphia	415	11	7	----	----	----	----	----	----	----	----	36	------	20	----	----	----	----	----	----	----	----
Norfolk-Washington	138	3	3	----	----	----	----	----	----	----	----	11	------	----	----	----	----	----	----	----	----	----
Portland-Spokane (Portland-Pasco)	198	2	7	----	----	----	----	----	----	----	----	20	------	10	----	----	----	----	----	----	----	----
Salt Lake-Great Falls(Pocatello-Great Falls) (day fields)	357	5	11	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
St. Louis-Indianapolis	235	4	4	----	----	----	----	----	----	----	----	19	------	2	----	----	----	----	----	----	----	----
Washington-Cleveland (Washington-Pittsburgh)	197	5	4	----	----	----	----	----	----	----	----	18	------	4	----	----	----	----	----	----	----	----
Total	2,078	----	47	----	----	----	----	----	----	----	----	151	------	36	----	----	----	----	----	----	----	----

AERONAUTIC DEVELOPMENT SERVICE

The aeronautic development service embraces all activities in connection with assisting communities in the selection and development of airports, the rating of airports, the promotion and correlation of aeronautic research, the publication and dissemination of aeronautic information, the publication of air-navigation maps and airway bulletins, and the general promotion work of the department looking toward the development of civil aeronautics.

The service is divided into an aeronautic information division, an aeronautics research division, an airport section, an airways-mapping section, and a section devoted to special research committees.

AERONAUTIC INFORMATION DIVISION

The contact office between the aeronautic industry and the general public with the Aeronautics Branch is the aeronautic information division, which division is charged with many of the promotion duties covered by the air commerce act of 1926. Specifically these duties include:

1. The publication and dissemination of current information relating to civil aeronautics through the semimonthly periodical, Air Commerce Bulletin.
2. The publication of airway bulletins—loose-leaf sheets describing airports, Department of Commerce intermediate landing fields, airways, air markings, meteorological conditions, and other data essential to air navigation.
3. The preparation and issuance of nonperiodic publications known as Aeronautics Bulletins, which are published from time to time on specific phases of civil aeronautics of both a technical and nontechnical character.
4. The preparation and dissemination of information for the aeronautic trade journals and newspapers maintaining special aeronautic columns, departments, or sections.
5. The compilation and publication of statistics covering accidents to civil aircraft and other statistics on the manufacture and operation of civil aircraft.
6. The general promotion work of the Department of Commerce encouraging the development of civil aeronautics in the United States.

During the past fiscal year this division has been reorganized. The airport activities, heretofore included in the work of the division, have been concentrated in a special section known as the airport section, which is directly responsible to the director of aeronautic development.

The activities of the aeronautic information division now are distributed as follows: Editorial section, statistics and distribution section, airway bulletin section, and aeronautics reference library.

EDITORIAL SECTION

One of the most important functions of the editorial section is the publication of the Air Commerce Bulletin, a semimonthly bulletin which goes to a mailing list of some 13,500 individuals, aeronautical clubs, libraries, airports, corporations, and others interested in aeronautics. The chief function of this bulletin is to make available to the aeronautic industry and the flying public accurate and official information which is collected and disseminated by the Aeronautics Branch.

The editorial section participates in the compilation and preparation of technical and nontechnical Aeronautics Bulletins which are published or revised at intervals by the aeronautic information division.

In keeping with the aeronautic promotional obligations of the Aeronautics Branch, this section also assists in the preparation of personal and radio addresses and articles for newspapers and magazines on various phases of civil aeronautics.

STATISTICS AND DISTRIBUTION SECTION

The statistics and distribution section is responsible for the compilation, analysis, and dissemination of all statistical data and other useful information on the various phases of civil aeronautics for the Aeronautics Branch. Among the most important of these are civil aircraft production, aircraft operation, aircraft accidents and casualties, and aids to air navigation; the preparation of statistical data; the coordination of information with other Government departments and organizations associated with aeronautics; the handling of correspondence that does not strictly pertain to the technical work of some other office of the branch; contacting the aeronautic industry and the general public, either by personal interview, correspondence, or through the distribution of publications of the branch.

Aircraft production.—Statistics concerning aircraft products for the calendar year 1929 were gathered by the Bureau of the Census, but are not yet available for publication. Comparable data for the calendar years 1919–1928 appear on page 62 of the annual report of this office for the fiscal year 1929.

A complete and current file containing copies of all airplane licenses and identification marks issued by the Aeronautics Branch has been established in this section for several purposes—one of which is to obtain current estimated production of new aircraft in advance of the usual census which is taken at the close of the year by this section.

The first report of estimated airplane production from January 1 to June 30, 1930, based on the Department of Commerce licenses, identifications, and reports from the Army and Navy, is set forth below.

TABLE 7.—*Estimated airplane production, January 1 to June 30, 1930*

Monoplanes:		
Open cockpit (landplane)—		
1 place	190	
2 place	64	
3 place	17	
Total open		271
Cabin (landplane)—		
1 place	1	
2 place	54	
3 place	17	
4 place	144	
5 place	2	
6 place	30	
7 to 10 place	[1] 20	
Over 10 place	[2] 7	
Total cabin		275
Flying boats		[3] 5
Convertibles		4
Amphibians		[1] 7
Total monoplanes		562

[1] 2 multiengine planes. [2] 6 multiengine planes. [3] 5 multiengine planes.

Biplanes:		
Open cockpit (landplane)—		
1 place	11	
2 place	180	
3 place	299	
5 place	3	
Total open		493
Cabin (landplane)—		
3 place	1	
4 place	1	
6 place	4	
7 place	2	
Total cabin		8
Flying boats		18
Convertibles		49
Amphibians		[4] 30
Total biplanes		598
Planes manufactured for experimental purposes for which complete information is not available		[5] 17
Military airplane deliveries		359
Airplanes exported		[6] 148
Grand total		1,684

Aircraft operation.—Statistics on aircraft operation were compiled during the year for both scheduled and miscellaneous flying. Excellent results have been obtained with the new scheduled aircraft operation report forms which were revised to include such items as passenger miles flown, gasoline and oil consumption, and information as to the system used by the transport companies in paying pilots and mechanics. The foregoing were in addition to the regular items which include routes operated, flying equipment used, trips scheduled (attempted and completed), miles flown, and passengers and express carried. A complete file of operation reports by 6-month periods for each air-transport company has been established for reference purposes.

TABLE 8.—*Scheduled airways operations statistics, July–December, 1929*

Item	Amount	Operators reporting
Passenger miles flown	22,094,693	41
Miles flown	15,840,161	45
Passengers carried	120,932	45
Express carried—pounds	890,660	45
Pilots on detail	562	42
Mechanics on detail	1,182	42
Other operating personnel	601	41
Total personnel	2,345	41
Pilots' pay:		
Base	$189.00	----------
Rate per mile, day	$0.05	----------
Rate per mile, night	$0.10	----------
Base and other total	$550.00	39
Mechanics' and riggers' pay:		
Monthly	$157.06	39
Hourly	$0.74	39
Trips possible	38,669	12
Trips attempted	35,772	42
Trips completed	34,294	42

[4] 8 multiengine planes.
[5] 1 multiengine plane.
[6] Does not include planes manufactured during 1929 that were exported during first 6 months of 1930.

TABLE 8.—*Scheduled airways operations statistics, etc.*—Continued

Item	Amount	Operators reporting
Percentage of attempted trips completed	95.9	42
Average hours flown per month per pilot	71	39
Equipment:		
Number of planes	495	43
Value	$10,434,589.22	43
Revenues:		
Passenger	$2,521,874.38	41
Mail	$9,762,076.57	45
Express and freight	$90,543.16	41
Miscellaneous	$590,969.84	41

Civil aircraft accidents and casualties.—One of the most important subjects handled by this section was the analysis of statistics on civil air accidents and casualties for the two six months' periods of the calendar year 1929. The statistics for each period included figures covering the years 1927 and 1928 which made available comparative figures for the years 1927, 1928, and 1929.

The accident statistics are constantly being enlarged upon and every effort has been made to procure and compile such data as would be most useful to insurance, indemnity, and finance companies, as well as the aeronautic industry and others interested in the promotion of safety in aeronautics.

There is a record of 1,698 accidents in 1929 as compared with 1,122 in 1928. The accident statistics for the first six months of 1930 are now being compiled. While the total number of accidents for 1929 represents an increase over the previous period, it must be borne in mind that the amount of flying increased in even greater proportion than the number of accidents.

TABLE 9.—*Civil air accident data, 1927–1929*

	January–December, 1927	January–June, 1928 [1]	July–December, 1928	January–June, 1929 [1]	July–December, 1929
Miles flown in scheduled transport operation	5,870,489	4,484,612	6,188,838	9,201,338	15,940,161
Miles flown in miscellaneous operations, including student instruction and experimental flying	[2] 30,000,000	12,000,000	48,000,000	47,000,000	63,000,000
Total miles flown, all services	35,870,489	16,484,612	54,188,838	56,201,338	78,940,161
Total accidents, all services	[3] 278	430	692	774	924
Miles flown per accident, all services	[3] 129,031	38,337	78,308	72,612	85,433
Total accidents, scheduled transport operations	[3] 25	35	51	61	76
Miles flown per accident, scheduled transport operations	[3] 234,820	128,132	121,350	150,842	209,739

[1] It should be borne in mind that weather conditions during the last 6 months of the calendar year are more favorable for flying than during the first 6 months, hence in making comparisons figures for corresponding periods should be used in each case.

[2] The figure of 30,000,000 miles listed under miscellaneous operations for 1927 was estimated from reports received on flying operations for 1928 as no operations report was made for 1927.

[3] The 1927 figures should not be used for comparative purposes as the accident reports for that period apparently were incomplete due to the fact that the inspection service was in the formative stage with a shortage of field personnel to carry on the work. For the same reason there were doubtless some unreported accidents in 1928.

TABLE 9.—*Civil air accident data, 1927–1929*—Continued

	January–December, 1927	January–June, 1928	July–December, 1928	January–June, 1929	July–December, 1929
Total accidents, miscellaneous operations	[1] 253	395	641	713	848
Miles flown per accident, miscellaneous operations	[1] 118, 577	30, 380	74, 883	65, 919	74, 292
Total fatal accidents, all services	[1] 99	97	130	127	183
Miles flown per fatal accident, all services	[1] 362, 328	169, 944	416, 837	442, 530	431, 367
Total fatal accidents, scheduled transport operations	[1] 4	5	7	9	15
Miles flown per fatal accident, scheduled transport operations	[1] 1, 467, 622	896, 922	884, 120	1, 022, 371	1, 062, 677
Total fatal accidents, miscellaneous operations	[1] 95	92	123	118	168
Miles flown per fatal accident, miscellaneous operations	[1] 315, 789	130, 435	390, 244	398, 305	375, 000
Total number pilot fatalities, all services	[1] 61	69	92	87	140
Miles flown per pilot fatality, all services	[1] 588, 041	238, 907	589, 000	645, 992	563, 858
Total number pilot fatalities, scheduled transport operations	[1] 4	4	5	9	14
Miles flown per pilot fatality, scheduled transport operations	[1] 1, 467, 622	1, 121, 153	1, 237, 768	1, 022, 371	1, 138, 583
Total number pilot fatalities, miscellaneous operations	[1] 57	65	87	78	126
Miles flown per pilot fatality, miscellaneous operations	[1] 526, 316	184, 615	551, 721	602, 564	500, 000

[1] The 1927 figures should not be used for comparative purposes as the accident reports for that period apparently were incomplete due to the fact that the inspection service was in the formative stage with a shortage of field personnel to carry on the work. For the same reason there were doubtless some unreported accidents in 1928.

As a result of a careful study, a new accident statistical analysis form was prepared to care for the additional data which were considered of importance. In order to procure the additional data, this section coordinated with the accident board of the licensing division with a view to revising the basic civil aircraft accident report. The accident report has been revised and this section now is able to compile, commencing with the first six months period of 1930, far more useful and valuable statistics on civil aircraft accidents and casualties.

Correspondence and distribution of publications.—The volume of correspondence continued to increase during the year. As many as 800 inquiries per month were answered by dictated letters by this section alone, while a monthly average of 4,500 other requests of various types were answered by information embodied in official bulletins which were transmitted to the inquirers with suitable form letters.

The foregoing figures indicate an increase of 15 per cent in letters written by this section and an increase of 40 per cent in the number of requests answered by bulletins. The average number of Aeronautics Bulletins and Air Commerce Bulletins distributed on request each month was approximately 25,000, and application blanks for pilot and plane licenses, etc., numbered 6,000 monthly.

The accompanying list of Aeronautics Bulletins which are published by the aeronautic information division indicates the nature

and scope of the publications available for use in answering requests for aeronautical information and for general distribution:

1. Civil aeronautics in the United States (undergoing revision).
2. Airport design and construction (in preparation).
3. Aeronautics trade directory.
4. Air marking.
5. Airports and landing fields.
6. Aeronautic publications.
7. Air commerce regulations.
7a. Airworthiness requirements of air commerce regulations.
7b. School supplement of air commerce regulations.
7c. Regulations governing entry and clearance of aircraft.
7d. Parachute supplement of air commerce regulations.
7e. Air commerce regulations governing scheduled operation of interstate passenger air transport services.
8. Airway map of the United States.
9. Establishment and certification of aeronautical lights and instructions for marking obstructions to air navigation.
10. List of air navigation charts.
11. Establishment and operation of Department of Commerce intermediate landing fields.
12. Aircraft engine testing.
13. Civil air accidents and casualties.
14. Relative lift distribution in any biplane.
15. Air traffic rules.
16. Airport rating regulations.
17. Airport management.
18. State aeronautical legislation and compilation of State laws.
19. Aviation training (undergoing revision).
20. Suggested city or county aeronautics ordinance and uniform field rules for airports.
21. Trend in airplane design as indicated by approved-type certificates (in preparation).
22. Gliders and gliding.
23. Medical examiners of the Aeronautics Branch.
24. The Federal airways system (in preparation).
25. Reduction of airplane noise.

General information and statistics.—In line with the policy of the branch in making official public records readily available, this section has installed a complete file of airplane licenses and identifications and pilot licenses. Files are also being kept on all types of airplanes, engines, propellers and pontoons for which the department has issued approved-type certificates, together with all aircraft and engines eligible for licenses without approved-type certificates. From these records the section is issuing daily and weekly reports of engineering notices on aircraft and engine approvals and also the quarterly statistical statement compiled on the status of aircraft, pilots, and mechanics by States.

AIRWAY BULLETIN SECTION

The chief function of this section is to compile airway bulletins—illustrated loose-leaf sheets describing airports, Department of Commerce intermediate landing fields, special warnings of unusual conditions that might affect the safety of flight, airways of the country, meteorological conditions, and other data essential to air navigation.

Airway bulletins contain two maps, one of the airport itself showing wind rose for the locality concerned, the immediately surrounding terrain, dimensions of the landing area, obstructions to approaches, markings, positions of available facilities, etc., and the other showing the airport's location with respect to near-by railroads, rivers, and the supporting community. In addition, the text portion of these bulletins gives the name of the airport, its class, method of operation, latitude and longitude, altitude above sea level, description of surface and runways, location and nature of obstructions, methods of marking and identification, description of lighting equipment, accommodations for aircraft and air travelers, meteoro-

logical data, and other information desired by pilots or aircraft operators.

During the past year 378 new airway bulletins were issued, 161 revised, and 260 reprinted. These airway bulletins are distributed to a mailing list of 3,500 individuals, organizations, and others interested.

A total of 1,041 airway bulletins has now been published and data are now in hand on 305 additional airports that are to be made the subjects of future bulletins. Also there are some 800 airports in operation or under construction, information on which is now being solicited by the section. At present airports are being established at the rate of approximately 60 a month and bulletins are being completed at the rate of 45 a month. During the past year approximately 2,400,000 copies of these bulletins have been distributed.

During the fiscal year 1930 the airway bulletin section maintained communication with more than 5,000 chambers of commerce, municipal airport committees, civic officials, airport owners, aircraft operators, and others actually engaged in or directly interested in the operation of airports. Approximately 16,000 letters were written to these and other contacts soliciting information concerning airports. In addition, some 3,000 letters of a general nature requesting specific information relative to airport and allied matters were answered.

AERONAUTICS REFERENCE LIBRARY

The aeronautics reference library has been used extensively the past fiscal year, not only by the Aeronautics Branch but also by persons outside the branch who were compiling data on or were conducting research work in aeronautics. The reference work more than doubled that of the previous year.

Complete files of current Aeronautics Bulletins and Air Commerce Bulletins and, so far as possible, complete sets of old Information Bulletins are contained in the library for reference purposes.

Close cooperation has been maintained by this library with the aeronautics trade division of the Department of Commerce as well as with libraries in Washington, from which material is often borrowed.

The library received 3,780 publications during the past year; 594 magazines and reports were indexed, 148 documents and 71 books were catalogued.

AERONAUTICS RESEARCH DIVISION

The aeronautics research division is engaged in a research program directed toward the development and improvement of aids to air navigation and the promotion of safety and comfort in flight, including such activities as research on aeronautic radio; investigations of aeronautic lighting; wind-tunnel studies; soundproofing of airplane cabins; reduction of noise from engines and propellers; research on special airplane-engine problems; and investigations on the strength of airplane joints and fittings. This division is subdivided into a radio secton, a lighting section, an aircraft-engine section, a wind-tunnel section, and an engineering section.

RADIO SECTION

Research in the use of radio in aeronautics dealt particularly with the further development of a visual-type radio range beacon system for course navigation on the civil airways, the development of a complete system of radio aids to facilitate blind landing of aircraft, and work on direction finders for aircraft, receiving equipment on aircraft, and airplane-engine ignition shielding.

Visual-type radio range beacon system.—The experimental work on visual-type radio range beacons, capable of serving 2, 4, or 12 courses, was completed. The sharpness of the beacon courses was increased from $\pm 2°$ to $\pm 1°$. Improvements were effected in the methods employed for fitting the courses to several airways simultaneously. Interference with other services caused by power radiation from the beacon on harmonics of the station carrier frequency was reduced to a negligible degree. Considerable improvement in the operation of the vibrating-reed course indicator used in the reception of signals from the visual-type beacon was obtained. In particular, the power required for operating this instrument was reduced fourfold. The accuracy of the measuring equipment for calibrating and adjusting the reeds was very much increased.

The visual-type radio range beacon is soon to undergo service tests on the civil airways. Seven beacon transmitters, constructed by the airways division, are scheduled for early installation on important air routes. In these installations, the radiobeacon and radiotelephone stations will both operate on the same radio-frequency, one service being interrupted for the other. Work was begun on a transmitting circuit arrangement which shows good promise for supplying both services simultaneously on the same radio-frequency.

Blind-landing aids.—The radio range beacon system serves to guide aircraft between important airports along a given airway regardless of weather conditions. However, means for permitting the safe landing of the craft under conditions of poor visibility are required before scheduled air-transport operation can become independent of the weather. A complete system of radio aids which shows very good promise of permitting routine blind landing was developed and set up at the College Park, Md., experimental flying field. This system includes three elements to indicate the position of the aircraft in three dimensions as it approaches and reaches the instant of landing. Lateral position (that is, the landing field runway direction) is given by a low-power radio range beacon, employing small multiturn loop antennas. Longitudinal position (that is, approach) is given by marker beacons. Height is given by an inclined ultrahigh-frequency radio beam, which effectively marks out the proper landing path. The weight of the additional equipment required on the airplane is only 15 pounds.

Direction finders.—A direction finder permitting aural or visual indication of the direction of the received signal was developed and tested in the laboratory. This model is now ready for flight testing.

Aircraft receiving equipment.—An automatic volume-control device for use in the reception of signals from the visual-type beacon was developed, thereby relieving the pilot of the duty of controlling the receiving set sensitivity as the distance of the airplane from the beacon station is varied.

A filter circuit arrangement (for connection in the receiving set output) was developed for use in receiving simultaneous radiotelephone and radiobeacon signals. This device directs the reed frequencies to the reed indicator and the speech signals to the head telephones.

A study was made of various types of receiving antennas for airplane use, the results obtained confirming the superiority of the vertical mast antenna developed by this division.

Airplane-engine ignition shielding.—Contact and cooperation with the aircraft and radio industries in the development of engine ignition shielding equipment was maintained. A commercial shielding assembly patterned after an assembly developed by this division met with marked success.

LIGHTING SECTION

Several series of tests on airway beacon lights, including photometric measurements and visibility observations, have been in progress throughout the year. Photometric tests on 24-inch standard airway beacons equipped with (*a*) silvered-glass mirrors, (*b*) metal mirrors, and with several types of lamps and several types of cover glasses for each type of mirror have been made.

Visibility tests from fixed stations, at approximately 3, 6, and 8 miles and from the air on the Washington-New York airway, were made on a number of different beacon lights. For these tests the lights were mounted on the roof of the east building of the Bureau of Standards. Candlepower measurements were also made on the several lights tested. As a result of the various candlepower measurements a revision of the candlepower values given in the airport beacon requirements of the Airport Rating Regulations was prepared.

Navigation lights for airplanes.—A design for an improved navigation light giving greatly increased candlepower has been worked out. A sample light has been constructed and a brief description with diagrams was published in the Air Commerce Bulletin, dated March 15, 1930. This work has been done largely in cooperation with the Bureau of Aeronautics, Navy Department.

Boundary lights.—Distribution measurements on the standard refracting boundary-light globes as well as over-all efficiency measurements have been made. The question of the color and the density for the red boundary-light globes is not definitely settled. The measurements made during the year show that the amount of light transmitted by different samples tested varies from about 4 to 15 per cent, showing an improvement in efficiency of light transmission of nearly 4 to 1.

A visibility test of gaseous discharge tube lamps—red, green, and blue—submitted as samples for use as boundary lights, was made by having 16 observers record their observations taken at two distances of approximately 700 and 3,200 feet, respectively. At the same time this group also observed the standard clear, red, and green refracting boundary-light globes. The gaseous discharge tubes, blue in color, were found unsatisfactory, being readily confused with green.

Wind indicators.—The improved reflector system designed for use with illuminated wind indicators, referred to in last year's report, has been adopted by the airways division as standard equip-

ment for wind indicators. Fabrics for use in wind cones have been obtained from several manufacturers. These fabrics have been treated so as to make the material itself more luminous when the interior of the cone is illuminated. An experimental installation has been made at the Naval Air Station, Anacostia, D. C., and a few observations taken.

Specifications for the colors of aviation glasses.—Measurements are in progress to determine, if possible, limits for the preparation of specifications for green and red glasses for use in airway and airport signal devices and for navigation lights on airplanes. This investigation is incomplete.

AIRCRAFT ENGINE SECTION

The aircraft engine section is engaged in experimental work which has to do chiefly with (1) perfecting mercury scales used to measure engine torque and (2) developing improved methods of correcting the observed torque for the slip-stream action. This windage effect can be eliminated if it is possible to use an air-straightening grid of suitable design between the propeller and the engine. The effect of grid thickness, size of opening, and over-all grid size are matters which can be determined only by actual experiments. The magnitude of the windage correction may also be determined by using another engine to spin the test propeller and measuring the torque due to the slip stream above. Both methods must be tried out and checked by dynamometer calibration of the engine used.

WIND-TUNNEL SECTION

The aerodynamic characteristics of the conventional types of control at large angles of attack of the airplane (corresponding to low air speeds) have been further studied by measuring the hinge moments of several ailerons of varying span on a Clark Y and USA 27 wing section. The work was carried out in the 10-foot wind tunnel of the Bureau of Standards on models of 60-inch span and 10-inch chord. This investigation, together with the measurements of rolling and yawing moments for the same ailerons (described in N. A. C. A. Technical Reports 298 and 343), completes the study of conventional ailerons as originally outlined.

Attention has now been directed to the study of rudders at large angles of attack. This problem is more complicated because a large interference effect is to be expected from the body. A number of models have been constructed and the required apparatus has been assembled.

The great majority of airplanes submitted to the Aeronautics Branch for approval make use of conventional types of control. The importance of a full study of the conventional control is therefore self-evident. Especially is it important to ascertain whether the safety of the airplane can be increased by small modifications of the standard type or by a suitable choice of shape and size.

ENGINEERING SECTION

During the past year a number of additional measurements were made on the sound transmission of single panels, using types of con-

struction and materials found in present-day airplanes. Equipment has been developed for measurements on the transmission of sound through the walls of the cabins of airplanes in flight and a number of tests were made. At the present time the apparatus is not adapted to absolute measurements of sound intensity or to the comparison of the absolute intensities within the cabins of different airplanes.

The information at hand has been made available to the industry by means of a paper presented at the fourth national aeronautic meeting of the American Society of Mechanical Engineers and by publication in the Air Commerce Bulletin of May 1 and September 15, 1930. Recently, a comprehensive account of the work has been prepared for publication as an aeronautics bulletin, which contains (1) a brief review of some fundamental phenomena of sound, (2) methods of measuring sound, (3) the soundproofing of airplane cabins, and (4) some work bearing on the reduction of propeller noise and the muffling of engines.

Strength of welded aircraft joints.—The fuselages and other parts of airplanes are in many cases made of chrome-molybdenum steel tubing, involving many joints. About 90 per cent of these joints are welded, using an oxyacetylene torch. A comprehensive study of this type of fabrication of aircraft structures has been undertaken. The welder who prepared the experimental joints for test qualified under a procedure prepared by the American Bureau of Welding, and the program was prepared in cooperation with numerous representatives of the aeronautic industry. The first report of the work, covering the strength and efficiency of 40 types of welded joints, is now in course of publication by the National Advisory Committee for Aeronautics.

AIRPORT SECTION

The airport section was reorganized December 2, 1929, and took over the duties previously handled by the field service section of the division of airports and aeronautic information. In general, the airport section is the point of contact between the Aeronautics Branch and the private and public airports of the country.

The number of airports and landing fields in the United States on June 30, 1930, was as follows:

Municipal airports	500
Commercial airports	558
Department of Commerce intermediate fields	306
Army airdromes	65
Naval air stations (including Marine and Coast Guard)	14
Marked auxiliary fields	210
Fields for miscellaneous Government activities	2
Total	1,655
Proposed airports	1,053
Airports and landing fields having night-lighting equipment	583

Field advisory service.—The work of this section includes conferences with States, counties, municipalities, and civic and trade organizations desiring assistance in the selection of airport sites and requesting information regarding the requirements for the development of suitable airports. A small group of airport specialists are

available for this service, which is rendered without charge upon request. These men are routed throughout the United States on carefully planned itineraries—the usual procedure calling for the inspection of a number of sites, perhaps a talk before a civic organization at noon or in the evening, and a conference or series of conferences with officials interested in the development of the airports and desiring information regarding the requirements of the airport rating regulations of the Department of Commerce. These specialists urge the importance of having experienced engineers make comprehensive studies and prepare plans for complete airport development, in order that every dollar invested in the project may be expended to the best advantage. It should be understood, of course, that the Department of Commerce representatives do not render this engineering service.

Rating of airports.—The Aeronautics Branch is charged under the air commerce act of 1926, with the examination and rating of air navigation facilities available for the use of aircraft in the United States as to their suitability for such use. Under this authority the requirements for the various airport ratings granted by the Government have been promulgated and set forth in detail for the use of any airport desiring a rating. To date two airports have been rated, the Pontiac (Mich.) municipal airport and the Denver (Colo.) municipal airport, both receiving the highest (A–1–A) rating. The fact that the majority of airports are, to-day, far from finished projects accounts in a large measure for the small number of airports rated. In many instances the airport authorities are developing an airport to a point where it will meet the requirements for a high rating as rapidly as funds permit. A large number of applications for ratings have been received, but in nearly every case where they were checked and the applicant advised wherein the airport failed to meet the requirements for the rating desired, it was requested that the application be held in abeyance until such time as the additional required work could be completed.

Work of a special nature.—Numerous conferences are held in the Washington office with State and local officials and individuals and companies interested in airport development or in the manufacture of the varied equipment that is required by a modern airport. The airport rating regulations have to be kept abreast of changes in the rapidly moving industry. Considerable work has been done by the section on the preparation of an Aeronautics Bulletin to be entitled "Design and Construction of Airports."

The amount of money invested in airports and the anticipated expenditures for 1930 and 1931 should be of considerable interest and value to the industry. Questionnaires have been sent to the airports of the country requesting detailed information about their investments. For several months a pressing follow up has been conducted to the end that the figures may be as complete and comprehensive as possible.

AIRWAYS MAPPING SECTION

This activity of the Aeronautics Branch is carried on by the airways mapping section at the Coast and Geodetic Survey. The maps compiled by this section are published on a scale of 1 to 500,000, or

about 8 miles to the inch. The maps published to date, usually referred to as "strip maps," cover strips 80 miles in width and from 200 to 400 miles in length—the size of each sheet being 11 inches wide and 24 to 48 inches long, a very convenient form and size which can be readily folded for use by the pilot. The sale of airway maps was taken over by the section during the year.

During the fiscal year 1930, this section started work on the program to issue a series of sectional area air-navigation charts covering the entire United States. This program has since been modified somewhat to bring it into accordance with the latest recommendations of the committee on aerial navigation maps which were approved by the Board of Surveys and Maps of the Federal Government at its November meeting. The revised program calls for a total of 92 maps.

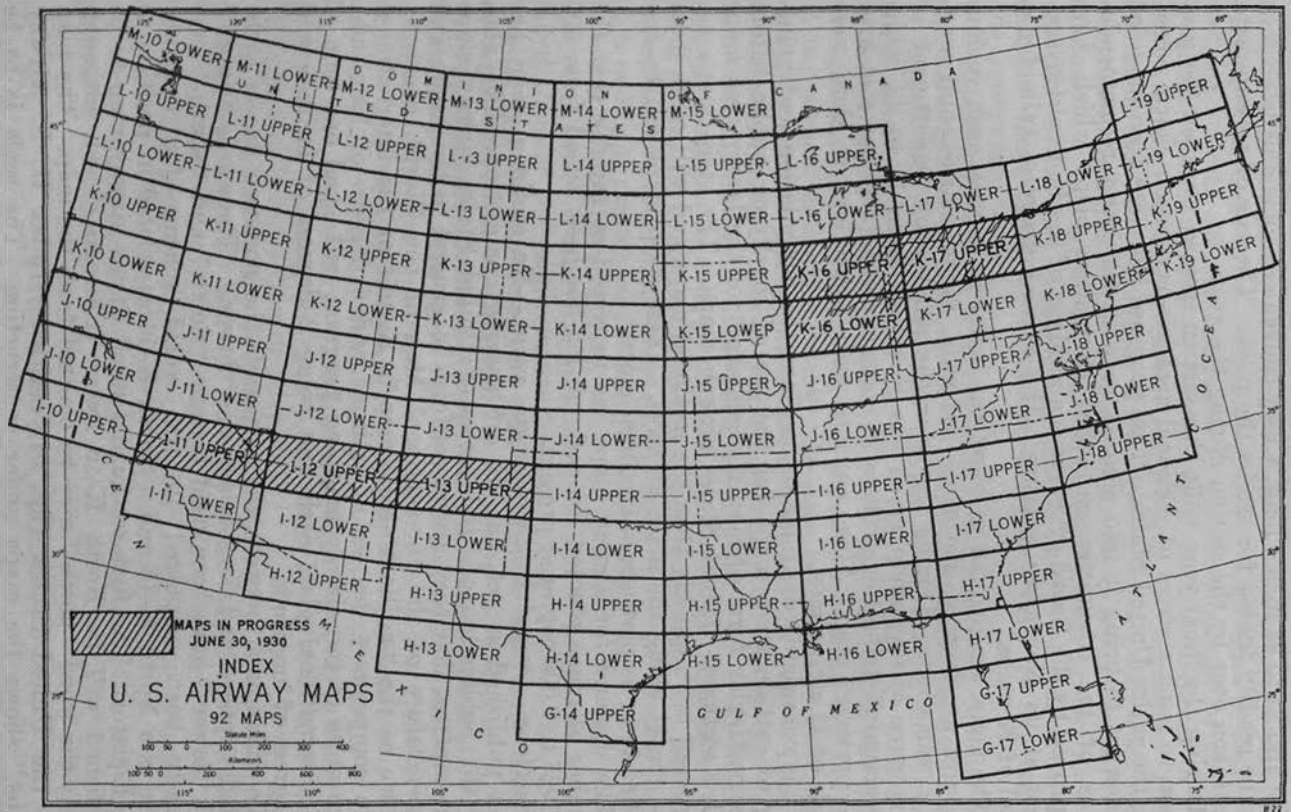
The maps are printed in color, the better to express such various features as streams, elevations, airports, flight courses, and magnetic variations. During the year the number of Department of Commerce airway strip maps was increased from 11 to 22, while the actual distribution of these 22 maps expanded 340 per cent over the previous year. Also, reprints with corrections to date were made of 11 strip maps.

It is considered desirable to continue the compilation and printing of certain strip maps for the use of the flying public before this particular form of map is abandoned for the larger area maps called sectional United States airway maps. The strip maps are prepared more quickly than the sectional maps and will serve those who travel along the main airways. These strip maps can be embodied later as portions of sectional maps.

The demand for airway maps has increased so rapidly that the number of maps printed for each edition has been raised from 500 in 1927 to 2,000 copies at present.

Sectional United States airways maps.—No sectional map has been published as yet, but six are nearing completion. The plan for the publication of this series of United States airway maps contemplates that they are to conform in general to the limits and nomenclature of the International Map of the World, generally known as the "millionth-scale map." A unit of the international map comprises 4 degrees of latitude and 6 degrees of longitude. Two units of the airway mapping program will equal one unit of the international plan, each unit being 2 degrees of latitude and 6 degrees of longitude.

To distinguish between the two units the northern one is to be called "upper," and the southern one "lower." The words "upper" and "lower" have been used because "north" and "south" have already been employed in the world scheme—for example, there is a North K–16 and a South K–16 as related in position to the Equator. The first sectional United States airway map to be published will be North K–16 lower (Chicago sheet), although likely the word "north" may be omitted from the map. The plan for the United States (fig. 5), entitled "Index U. S. Airway Maps," shows the maps under construction. The scale is to be 1 to 500,000.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G-14 UPPER
G-17 UPPER
G-17 LOWER
CANADA
GULF OF MEXICO
ATLANTIC OCEAN
MAPS IN PROGRESS JUNE 30, 1930
INDEX
U. S. AIRWAY MAPS
92 MAPS

FIGURE 5

One of the first maps of the United States airway map series thought desirable to publish is the International Map K–17 upper, which includes the important cities of Detroit, Buffalo, and Montreal. The cooperation of Canadian officials, especially the Hon. J. D. Craig, director general of surveys, has aided materially in this work.

Mileages.—The measurement of distances between airports or between centers of cities for the air mail service of the Post Office Department, for air-transport operators, the aeronautic development service of the Aeronautics Branch and others was continued, and the file of such distances is now quite extensive.

Distribution of airway strip maps and charts.—The number of maps distributed by the Department of Commerce for the fiscal years 1929 and 1930 follows:

	1929	1930
Department of Commerce airway maps	3,529	12,004
Army air navigation maps	9,870	13,657
Navy aviation charts	956	731
Total	14,355	26,392

The increase in total sales in 1930 over the number of sales in 1929 amounts to practically 84 per cent.

The smaller number of Navy aviation charts issued during 1930 as far as this list shows is explained by the fact that after September 18, 1929, the larger orders were filled by the Hydrographic Office and only a few were sold by the Coast and Geodetic Survey.

SPECIAL RESEARCH COMMITTEES

The Aeronautics Branch has organized a number of special cooperative research committees under the chairmanship of the director of aeronautic development for the purpose of investigating and reporting upon certain outstanding problems as follows:

FACT-FINDING COMMITTEE ON CONTROL OF AIRPLANE HANGAR FIRES BY AUTOMATIC APPLICATION OF WATER

The fact-finding committee on control of airplane hangar fires by automatic application of water was organized following a series of conferences between representatives of the aeronautic industry and the National Board of Fire Underwriters to consider the board's proposed code for the construction and protection of airports, which include requirements dealing with automatic sprinklers. The purpose of the committee was to plan and conduct tests to determine the practicability of applying the principle of automatic issue of water from sprinkler systems to control fires in airplane hangars. Its membership comprised representatives of the Aeronautics Branch, the Army Air Corps, the Bureau of Aeronautics of the Navy Department, the National Advisory Committee for Aeronautics, the Aeronautical Chamber of Commerce of America, the National Automatic Sprinkler Association, the National Board of Fire Underwriters, and the Underwriters' Laboratories.

The tests were conducted from April 22 to May 2. The committee has completed its report, which will be published and made available to the public without charge.

LIAISON COMMITTEE ON AERONAUTIC RADIO RESEARCH

Realizing the vital importance of the application of radio to aeronautics and the necessity of coordinating governmental and industrial research in this field, a liaison committee on aeronautic radio research was organized in January, 1930, for the purpose of making a survey of research activities and focusing such research on the early solution of the most pressing problems with the minimum duplication of effort.

This committee consists of representatives of the Aeronautics Branch and the Bureau of Standards of the Department of Commerce; the Army Air Corps; the Bureau of Aeronautics, Navy Department; the National Advisory Committee for Aeronautics; the Aeronautical Chamber of Commerce of America; the American Air Transport Association; the Institute of Radio Engineers; the National Electrical Manufacturers' Association; and the Radio Manufacturers' Association.

The work of the committee is divided into the following: (1) Survey of research in progress on aeronautic radio problems; (2) survey of problems on which research should be undertaken or accelerated; and (3) recommendation of agencies to carry on the work outlined in (2).

Soon after its organization the committee began its surveys and studies, the results of which are presented in its first report published by the Aeronautics Branch on June 1, 1930.

The liaison committee on aeronautic radio research is a standing committee which will continue its studies and investigations. It is believed it will render a valuable service not only to governmental and industrial research agencies, but to the entire aeronautic industry by directing research and experimentation toward radio problems the solution of which is most important to the advancement of aeronautics.

COMMITTEE ON AIRPORT ZONING AND EMINENT DOMAIN

The organization of a cooperative committee on airport zoning and eminent domain on March 11, 1930, was the result of many requests received from city officials, airport managers and engineers, and others interested in the development of adequate airports, for information and suggestions as to suitable airport-zoning ordinances to insure protection to the flying public against hazards that might be developed in the vicinity of airports.

This committee consists of representatives of the Aeronautics Branch, the Bureau of Standards, and the advisory committee on city planning and zoning of the Department of Commerce; the air transport section and the airport section of the Aeronautical Chamber of Commerce of America; the committee on aeronautical law of the American Bar Association; the National Conference on City Planning; the Planning Foundation of America; and the United States Chamber of Commerce.

The committee is now engaged in a comprehensive series of studies covering the problems involved in the protection of airports against developments tending to jeopardize the safety of operations and otherwise reduce their effectiveness.

COMMITTEE ON STANDARD SIGNAL SYSTEMS FOR AIRPORTS

In an endeavor to bring about uniformity in the matter of air-traffic control, a committee on standard signal systems for airports was organized in December, 1929. This committee is composed of representatives of the Aeronautics Branch and Bureau of Standards of the Commerce Department; the Army Air Corps; the Bureau of Aeronautics, Navy Department; the National Advisory Committee for Aeronautics; and the Aeronautical Chamber of Commerce of America.

An extensive survey of existing methods of traffic control was made. Questionnaires were sent to all the major airports of the country and suggestions were invited from all persons interested. The general reaction to the survey was that the studies were timely, and that a solution of the problem of traffic control at airports was vital to the advancement of the industry.

An investigation was also made of the systems in use at foreign airports, including Croydon, England; Tempelhof, Berlin; and Le Bourget, Paris.

The questionnaires were digested and tests (both day and night) were made at Bolling Field, Washington, D. C., of a number of types of equipment.

As a result of its studies and tests the committee feels that the problem of traffic control is one that will be constantly changing with the advancement of air transportation, and one which will require constant work and study as conditions change. The committee is now preparing its preliminary report setting forth its findings and recommendations. This report will be printed by the Aeronautics Branch and made available to all who may be interested.

COMMITTEE ON AIRPORT DRAINAGE AND SURFACING

The absence of uniform and thorough applications of adequate drainage and surfacing for airports has been responsible for accidents to planes in landing and taking off from airports and landing fields, for delays and interruptions in departures and arrivals of aircraft, and has involved the wastage of thousands of dollars in time and money in connection with airport projects.

To undertake the solution of the problems of drainage and surfacing in so far as they relate to airport engineering and construction, the technical resources of the American Engineering Council, the American Road Builders' Association, and the Aeronautics Branch have joined into one group, and these organizations have designated representatives to serve on a committee on airport drainage and surfacing organized in June, 1930.

SPECIAL COMMITTEE ON AIR-SPACE RESERVATIONS

To bring about proper coordination and uniformity of porcedure in the matter of air-space reservations to be set aside by Executive

order for national defense or other purposes, as provided under section 4 of the air commerce act of 1926, on November 15, 1929, the Assistant Secretary invited the War and Navy Departments to designate representatives to serve on a special committee to study this matter.

This special committee made a careful study of the problem and rendered its report, which recommended that air-space reservations be divided into two classes: (*a*) Air-space reservations set aside by Executive order, and (*b*) certified high-explosives danger areas. The report also recommended that the three Assistant Secretaries for Aeronautics of the War, Navy, and Commerce Departments, respectively, be constituted a board to consider all applications for such air-space reservations and submit them to the President with suitable recommendations. This recommendation was transmitted to the President by the Secretary of Commerce on February 18, 1930, and approved by the President on the same date.

ADMINISTRATIVE DIVISION

The administrative division, composed of a personnel unit, an accounting unit, a files unit, and a supply unit, is the service organization for the various divisions and sections of the Aeronautics Branch. The division is specifically charged with the handling of all budget, appropriation, and accounting matters; the handling of appointments of personnel and personnel records; the maintenance of central file records; the purchasing of and accounting for all property, including special aeronautical equipment of all kinds; and all other general administrative work relating to the operation of the branch.

Funds for carrying on the work of the branch are appropriated under two titles, "Aircraft in commerce" and "Air navigation facilities." The appropriation "Aircraft in commerce" is used for salaries and traveling expenses of inspectors engaged in the inspection and licensing of aircraft and airmen; for salaries of employees necessary to carry on the work in the Washington office, and for the testing of aircraft engines and for conducting certain research.

The appropriation "Air navigation facilities" is used primarily for the construction and maintenance of civil airways. A portion of this appropriation is, however, used for research work looking toward the development of aids to air navigation.

Following is a tabulation of the amounts that have been appropriated under these two heads since the Aeronautics Branch began to function:

Fiscal year	Aircraft in commerce	Air navigation facilities	Total
1927 [1]	$250,000	$300,000	$550,000
1928	700,000	3,091,500	3,791,500
1929 [2]	859,500	4,659,850	5,519,350
1930	958,000	5,458,620	6,416,620
1931	1,260,830	7,944,000	9,204,830

[1] Second deficiency act, fiscal year 1926, approved July 3, 1926.

[2] Includes under "Aircraft in commerce," $72,500 appropriated by the second deficiency act of 1928 and $85,000 appropriated by the second deficiency act of 1929 and under "Air navigation facilities," $1,000,000 appropriated by the second deficiency act of 1928.

During the last fiscal year numerous additional tasks were imposed upon the branch including the inspection of scheduled interstate passenger-carrying air lines for certificates of authority to operate; the flight testing of pilots for passenger-carrying ratings in various classes and weights of aircraft; the inspection and testing of parachutes for approved-type certificates; and the examination of parachute riggers for licenses. In addition to these specific tasks, the services rendered to the aeronautical public in the form of current statistical and general information on commercial aviation has been materially increased. These increased activities, together with the constantly increasing volume of work made necessary by the renewal of licenses previously issued, have combined to increase approximately 100 per cent the total volume of work to be performed. During the fiscal year 1930 the personnel was increased approximately 16 per cent. The handling of so large an increased volume of business with such a relatively small increase in personnel was only possible through much overtime work and the most rigid application of efficiency principles as well as the elimination of all phases of the work not absolutely essential to the accomplishment of the task at hand. The personnel paid from the appropriation "Aircraft in commerce" for the past four years is as follows:

Date	District of Columbia	Field	Total
June 30, 1927	51	37	88
June 30, 1928	104	68	172
June 30, 1929	146	127	273
June 30, 1930	166	150	316

During the year all airplane engines of the Aeronautics Branch have been overhauled at the Department of Commerce depot at Bolling Field, Washington, D. C., which depot was completed about the close of the last fiscal year. By this work, the average cost of the major overhaul of an engine was reduced to one-half the former cost.

A complete and uniform filing system has been worked out for all field offices, and a set of administrative memoranda, describing in detail the procedure to be followed in the execution of administrative problems arising in the field, has been prepared and distributed to the field offices for their reference and guidance.

During the year the Aeronautics Branch purchased $121,000 worth of accountable property, which included 12 airplanes and 5 airplane engines.

TABLE 10.—*Progress of United States civil aeronautics in statistics*

[Data for first half 1930 not available at this time]

	1926	1927	1928	1929
AIR TRANSPORT				
Airplane miles flown, all operators	4,318,087	5,870,489	10,673,450	25,141,499
Airplane miles flown daily, average for the year	11,830	16,083	29,242	68,881
Passengers carried	5,782	8,679	49,713	173,405
Express and freight carried—lbs.	1,733,090	2,263,580	1,848,156	1,866,879
Airplane miles flown with mail [1]	[2] 4,240,407	[2] 5,543,578	7,846,296	14,869,166

[1] All air-mail routes, whether domestic or foreign.
[2] Includes all mail routes, whether Government or contract.

TABLE 10.—*Progress of United States civil aeronautics in statistics*—Continued

	1926	1927	1928	1929
AIR TRANSPORT—continued				
Total mail carried [1] ..... lbs.	[3] 810,855	[3] 1,654,165	4,063,173	7,772,014
Mail carried by contract [1] ..... do	377,206	1,270,299	4,063,173	7,772,014
Mail income to contractors [1]	[3] $765,549	[3] $2,643,454	$7,432,721	$17,042,521
Miles of mail airways, Dec. 31 [1]	8,039	7,832	14,561	26,597
Average mail income per scheduled round trip [4]	$295	$654	$994	$1,205
Average mail load in pounds per scheduled round trip [4]	112	273	489	617
Average income per pound of contract mail [4]	$2.03	$2.08	$2.03	$2.01
Average mail income per contract mile flown	$0.39	$0.625	$0.94	.....
Miles of all airways in operation, Dec. 31	8,404	9,122	16,667	36,000
Airways in operation, Dec. 31 ..... number	[5] 18	22	47	65
Lines in operation, Dec. 31 ..... do	[5] 18	23	63	97
Mail operators, Dec. 31 ..... do	[5] 15	16	21	22
Passenger operators, Dec. 31	6	14	30	31
All operators, Dec. 31 ..... number	[5] 18	19	37	35
Total revenues, all operators	[6] $765,549	[6] $2,643,454	[7] $8,349,817	.....
Average passenger-mile rate	$0.12	$0.106	$0.11	$0.12
Airplanes in service and reserve ..... number	.....	128	325	[8] 525
Value of above	.....	[8] $1,838,462	[9] $7,000,000	[9] $12,000,000
Pilots employed ..... number	.....	107	[10] 308	[8] 500
Total personnel employed	.....	462	[11] 1,496	[9] 2,000
Passenger and express income	.....	.....	[12] $599,059	.....
MISCELLANEOUS				
Airplane miles flown	[13] 18,746,640	[13] 30,000,000	[13] 60,000,000	[13] 110,000,000
Miles lighted airways, Dec. 31	2,041	4,468	6,988	12,448
Under construction	1,168	1,277	2,314	1,352
Electric and gas beacons, Dec. 31	612	760	1,188	1,311
Lighted intermediate fields, Dec. 31 ..... number	92	134	210	285
Radiobeacon stations, Dec. 31 ..... do	.....	.....	2	9
Radio communication stations, Dec. 31 ..... do	17	19	29	34
Weather Bureau regular stations, Dec. 31	202	207	206	207
Weather Bureau airways stations, Dec. 31	12	23	95	200
Private light beacons, Dec. 31	.....	8	54	114
Pilots licensed or pending ..... number	.....	3,242	5,605	10,215
Student permits, issued or pending ..... do	.....	545	10,528	20,400
Approved models of airplanes ..... do	.....	21	96	279
Approved models of engines ..... do	.....	.....	13	35
Airplanes licensed ..... do	.....	2,299	4,156	6,685
Airplanes identified ..... do	.....	851	2,164	3,155
States with regulatory legislation	7	13	18	20
States with "uniform State law" only	9	10	10	19
States with miscellaneous legislation	3	3	3	1
States with no legislation	29	22	17	8
Municipal airports, Dec. 31	.....	240	368	453
Private and commercial airports, Dec. 31	.....	263	365	495
Navy airports, including Marine Corps, Dec. 31	.....	17	17	14
Army, National Guard, and reserve airports, Dec. 31	.....	62	64	68
Marked auxiliary fields, Dec. 31	.....	320	340	235
Proposed airports, Dec. 31	.....	422	921	1,413
Production of airplanes ..... number	1,186	1,995	4,346	[9] 6,200
Value of airplanes	$8,871,027	$14,504,999	$43,812,318	[8] $75,000,000
Total value of all air products	$17,694,905	$21,161,853	$64,662,491	[9] $100,000,000
Exported airplanes	50	63	162	354
Exports (airplanes, engines, and parts)	$1,027,210	$1,903,583	$3,664,723	$9,202,385
Concerns engaged in air industry ..... number	600	900	1,400	[9] 1,500
Government consumption, airplanes (Army, etc.) ..... number	532	621	857	[9] 700

[1] All air-mail routes, whether domestic or foreign.
[3] San Francisco-Chicago operated by post office until June 30, 1927; Chicago-New York, by post office until Aug. 31, 1927. All subsequent mail carried by contract.
[4] Domestic only as foreign mail is carried on a mileage basis.
[5] Includes post office.
[6] Mail income only. No data on passenger and express income.
[7] Includes all reports on mail revenue, also passenger and express revenue from all but 5 operators.
[8] Reports from 20 of the 22 operators.
[9] Estimate.
[10] Reports from 33 of 35 operators.
[11] Reports from 27 to 33 of the 35 operators.
[12] Reports from 21 of 35 operators.
[13] Estimate based on reports.

SUMMARY AND CONCLUSION

The aeronautic industry.—Manufacturers of aircraft, who are just as skilled in the principles of business economics as they are in designing, constructing, and flying aircraft, are paying strict attention to the needs and desires of an intelligent and discriminating aircraft market. They are making every effort to design and produce aircraft which their experience and studies have indicated are what the public wants. At the same time they are projecting plans continually on new developments, new designs, new features in an effort to keep in the van of public desire.

Cities and towns are continuing to realize more and more that air transportation plays a very definite and important part in our national transportation scheme. These foresighted communities not only are establishing and encouraging the establishment of airports, but are taking steps to develop them to the fullest extent of existing knowledge and experience. This is particularly true of the air terminals in the larger cities that now are serving air lines both day and night as well as those that are in an advantageous position to render such service.

The passenger air transport lines are constantly making inroads into that large group of people who could travel by air but for one reason or other have elected to remain with surface transportation. Those air lines that render a service clearly advantageous in time over other means of travel or which advantageously augment surface transportation are doing a substantial business, and the tendency points to continued increase.

When the provisions of the Watres Air Mail Act are given full force and effect, this legislation will have two outstanding stimulating features on the industry and also will be beneficial to the public:

First. Air mail will be extended to various parts of the country not now being served, by the utilization of existing air passenger transport lines.

Second. It will assist materially in the establishment of a more comprehensive passenger service throughout the Nation by placing present air mail carriers in the passenger-transportation business.

These two features should contribute to the building up of the passenger air transport industry to the point where there should be no question about the completeness and fitness of service available for any proper demand that may arise.

For the purpose of surrounding air lines engaged in the scheduled transportation of passengers in interstate commerce with all possible safeguards and with the view to providing air transportation with virtually the same uniformity of operation as is now enjoyed by the major railroads and steamship systems, there was prepared and promulgated during the year a supplement to the Air Commerce Regulations requiring the operators of scheduled air passenger transport services in interstate commerce to obtain from the Secretary of Commerce a certificate of authority to operate such service.

The certificate of authority will be issued only to those operators who effect complete compliance with the new regulations and the interpretations thereunder. When placed in full operation and effect, these regulations, which constitute a standard or code of minimum requirements governing the operation of scheduled interstate

air passenger routes, are expected to bring about unprecedented records for safety and reliability in this phase of civil aeronautics.

TABLE 11.—*Air-mail operation statistics*

C. A. M. No.[1]	Domestic routes	January-June, 1930 (inclusive)					January-June, 1929 (inclusive), revenue per scheduled mile
		Miles of service		Total weight of mails dispatched	Amount paid to contractor	Revenue per scheduled mile	
		Scheduled[2]	Actually flown				
				Pounds			
1	Boston-New York	85,813	75,501	59,275	$138,986.88	$1.62	$2.39
2	Chicago-St. Louis	200,784	181,064	27,216	83,544.36	.42	.75
3	Chicago-Dallas	746,954	655,479	204,445	592,425.51	.79	.92
4	Salt Lake City-San Diego	439,366	409,045	417,770	1,014,475.72	2.38	3.16
5	Salt Lake City-Pasco	390,594	340,351	130,615	367,041.34	.94	1.49
8	Seattle-Los Angeles	386,108	370,704	124,053	339,215.93	.88	.84
9	Chicago-Minneapolis	490,903	465,037	107,324	294,971.41	.60	.55
11	Cleveland-Pittsburgh	90,684	79,941	30,794	92,384.07	1.19	2.50
12	Cheyenne-Pueblo	75,505	68,218	41,843	34,711.27	.46	.48
16	Cleveland-Louisville	134,314	118,708	36,234	44,094.53	.33	.35
17	New York-Chicago	682,001	599,929	809,141	662,570.54	.98	.97
18	Chicago-San Francisco	1,417,800	1,330,808	925,485	1,872,920.49	1.32	1.38
19	New York-Atlanta	494,697	444,213	213,765	640,943.99	1.30	1.62
20	Albany-Cleveland	143,039	128,725	31,698	35,184.04	.26	.35
21	Dallas-Galveston	116,268	112,992	18,272	52,804.07	.45	.60
22	Dallas-Brownsville	192,322	182,073	43,006	124,287.70	.65	.65
23	Atlanta-New Orleans	175,088	169,740	52,915	92,600.81	.53	.44
24	Chicago-Cincinnati	204,670	174,157	34,073	50,089.78	.24	.51
25	Atlanta-Miami	279,409	266,048	88,396	128,757.47	.46	.39
26	Great Falls-Salt Lake City	234,137	229,384	29,606	73,272.73	.31	.37
27	Bay City-Chicago	303,708	273,746	87,783	77,989.97	.26	.28
28	St. Louis-Omaha	293,514	276,783	81,632	64,020.61	.22	.13
29	New Orleans-Houston	116,037	115,288	25,203	25,190.15	.22	.20
30	Chicago-Atlanta	319,539	298,229	57,804	44,852.51	.14	.14
32	Pasco-Seattle	189,416	176,253	83,028	7,472.57	.39	
	Total	8,202,670	7,542,416	3,761,376	6,954,808.45	[3].85	[3]1.00

[1] C. A. M.=Contract air mail.
[2] Miles scheduled as estimated by Post Office Department on basis miles of route times trips scheduled. Actual miles flown on regular schedule plus ferry and test mileage amounts to practically the same as scheduled mileage.
[3] Average revenue per scheduled mile for the total of all contract air-mail routes.

In regard to the safety feature of civil aeronautics, we are hopeful that suitable legislation, dealing with the investigation, recording, and publication of the causes of accidents in civil air navigation in the United States, will be enacted. Such legislation should give the department more authority with respect to the procedure surrounding the investigation of civil aircraft accidents than now exists. This is desirable in order that the department may effect more complete investigations of such accidents.

While progress in the manufacture and sale of aircraft for miscellaneous use has not continued so rapidly in the last six or eight months of the fiscal year as during the fore part of the year, it is gratifying to note the continued development of scheduled air transportation of mail, passengers, and express.

Of the 13,000 pilots holding all types of Department of Commerce licenses at the close of the fiscal year, approximately 600 were employed on the scheduled air mail and passenger lines. These airline pilots are paid on the basis of quality, and the longer they serve on a particular air line, or on air lines in general, the more valuable they become to the operators.

The number of pilots not employed on schedule air-line operations was close to 100 per cent more than the number of licensed airplanes on record at the close of the year.

From the point of view of the Aeronautics Branch, this is not an undesirable situation. In fact, it is indicative of a better market for aircraft and indicates quite clearly the existence of a potential market. The Aeronautics Branch has no definite means of determining how many of the licensed pilots not engaged in scheduled air-transport work undertook training for Federal licenses as an educational or avocational activity. Neither does it know how many licensed pilots are waiting for further developments in aircraft and engines, both from the scientific and financial viewpoint.

The light-powered airplane offers a possibility for greater private, sport, and recreational flying, and its further development doubtless will reach many licensed pilots whose activities might be restricted to the minimum requirements necessary to hold their licenses. Furthermore, it should reach countless thousands who either have never flown before or who have turned to gliding as a medium offering initial possibilities for developing air sense and acquiring certain fundamentals of flight.

The light-powered airplane should be of particular service and advantage to those who have passed through the various stages of gliding and now are looking further into the field of flight.

The Aeronautics Branch foresaw the possibility of light-powered airplanes with limited or restricted range and performance many months ago, and, in an effort to encourage their development, it waived the requirements for approval of their power plants and propellers on the ground that such power plant and propeller as will be used in light aircraft will be "merely an auxiliary and not a necessary essential to safe flight."

In the general field of air transportation, two features are outstanding: One is the increase in international operation of airplanes and the other is the commercial possibilities of lighter-than-air craft

On June 30, 1930, planes operating on schedule in the United States were flying 90,187 miles per day. Planes owned and operated by commercial companies in the United States were flying 12,995 miles per day on schedule to Canada, Mexico, the West Indies, and Central and South America. The total domestic and foreign scheduled daily mileage flown by American aircraft (103,182) represented an increase of 34,153 miles flown per day over the corresponding period last year.

The world flight of the *Graf Zeppelin* and its numerous Atlantic crossings, coupled with the flight to Canada of the British airship *R–100*, served to renew confidence in the commercial possibilities of lighter-than-air travel for long distances, and particularly trans-oceanic.

In addition to its regular duties of examining aircraft and airmen for license; maintaining and extending the Federal airways system; assisting communities in the selection of airports; conducting research on problems of air navigation including aeronautic radio; enforcing the Air Commerce Regulations; determining the causes of civil aircraft accidents; and furnishing the public with information pertaining to civil aeronautics, the Aeronautics Branch of the Depart-

ment of Commerce during the fiscal year 1929–30 developed and placed in effect the following:

1. Regulations requiring operators of scheduled interstate passenger air-transport services to obtain from the Secretary of Commerce a certificate of authority to operate such services. The certificate will be issued only to those operators who comply with the regulations and the interpretations thereunder.
2. Regulations providing for approval by the Department of Commerce of gliders as to airworthiness and for the licensing of gliders and glider pilots.
3. Regulations providing for the examination, test, and issuance by the Department of Commerce of approved-type certificates for parachutes and also for the creation of a "parachute rigger's license." The examination, test, and issuance of approved-type certificates for parachutes are made upon application by the manufacturers of parachutes.

Regulations providing for the examination and rating by the Department of Commerce of civilian schools giving instruction in flying, as to the adequacy of the course of instruction, as to the suitability and airworthiness of the equipment, and as to the competency of the instructors, were promulgated shortly before July 1,

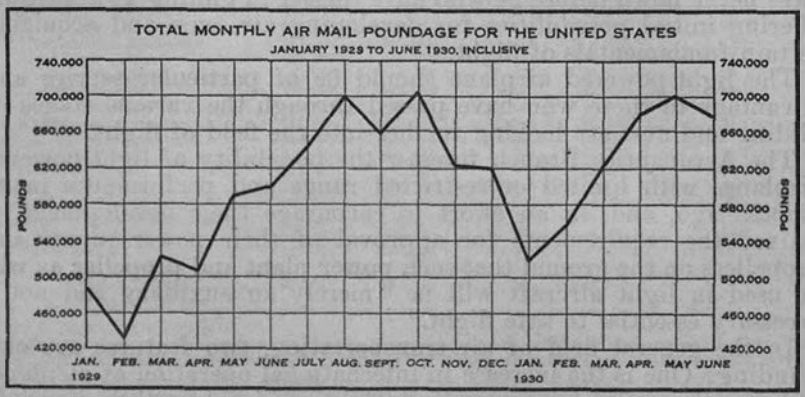

FIGURE 6

1929. However, the certificates of approval were not issued until the fiscal year just closed.

Under its program of airways development, the aeronautics branch during the last fiscal year lighted 3,321 miles of airways, established and lighted 56 intermediate landing fields, and installed and operated 218 standard revolving beacon lights for the guidance of airmen after dark. Five thousand six hundred and fifty miles of airways were equipped with automatic telegraph-typewriter circuits which collect and disseminate weather information along the airways, and 13 radio broadcasting stations were placed in operation for the broadcast of this weather information to planes in flight at regular intervals both day and night. Two radio range beacons, which guide pilots along the airways by means of radio signals, also were placed in operation, and 27 were completed to the point where service operation will be started between July 1 and September 1, 1930.

As the foregoing aids to air navigation not only have justified their existence, but have proved to be indispensable from the standpoint of safety and reliability of aircraft operation, funds available from current appropriations have been allocated to provide more

of these facilities. During the current fiscal year, 3,000 miles of additional airways will be lighted, 33 additional radio range beacon stations will be established, 2,800 miles of automatic telegraph-typewriter circuits will be placed in operation, and 20 radio communication stations will be installed. Upon the completion of these 20 additional radio communication stations, there will be scarcely a square mile of area in the United States where flying is a regular activity, that a pilot can not receive broadcasts of weather information while in flight.

Airport specialists of the Aeronautics Branch engaged in 871 conferences with cities and municipalities, assisting them in the selection of sites and supplying information as to the requirements for the development of suitable airports.

At the close of the fiscal year 1929–30, the status of active licenses and approvals, issued by the Aeronautics Branch following examinations and inspections, was: Licensed planes, 6,684; unlicensed planes, 3,089; licensed pilots, 13,041; licensed mechanics, 8,843; aircraft holding approved-type certificates, 334; engines with approved-type certificates, 54; propellers with approved-type certificates, 174; aircraft approved for license but without approved-type certificates, 230; approved civilian schools giving instruction in flying, 45.

Under its aeronautic development program, the Aeronautics Branch organized special cooperative research committees which undertook studies of such subjects as:

The effectiveness of the automatic application of water in controlling airplane hangar fires.

The development of standard signal systems for airports which will be suitable for both day and night use for controlling traffic on and in the vicinity of airports and for communicating special information to pilots.

Aeronautic radio research now in progress and of those radio problems the solution of which will assist in bringing about the highest degree of safety and reliability in air transportation.

Hazards that might be developed in the vicinity of airports through the construction or existence of buildings, smokestacks, radio towers, and similar obstructions to air navigation.

The problems involved in airport drainage and surfacing. In this latter study, the Aeronautics Branch has the cooperation of the American Engineering Council and the American Road Builders Association.

From the beginning, the Aeronautics Branch has adhered to a policy leading to a realization of the following principles: (*a*) Airworthy aircraft, adequately equipped and efficiently maintained; (*b*) flown by competent pilots; (*c*) over suitably equipped airways; (*d*) in conformity with standard air-traffic rules.

Since this policy has proved to be absolutely sound, it undoubtedly offers the best way of cooperating with the industry and the bringing about of public acceptance and use of properly established air commerce. Therefore, it will continue to be the basis for planning the activities of the Aeronautics Branch in the promotion and regulation of civil aeronautics, authorized by the air commerce act of 1926.

Very truly yours,

CLARENCE M. YOUNG,
Assistant Secretary of Commerce.

RADIO DIVISION

DEPARTMENT OF COMMERCE,
RADIO DIVISION,
Washington, July 1, 1930.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: In response to your request I furnish the following condensed report of the work of the radio division during the past fiscal year, including references to related developments which have taken place during that period.

LEGISLATION

In an act approved December 18, 1929, Congress extended the administrative control of the Federal Radio Commission over radio communication until such time as may otherwise be provided for by law.

Senate Joint Resolution 176 was introduced on May 12, 1930, providing for the transfer of the functions of the radio division of the Department of Commerce to the Federal Radio Commission. This resolution was passed by the Senate. A favorable report was made on the resolution by the Merchant Marine and Fisheries Committee of the House, but no further action has been taken on the measure.

House Joint Resolution 337 was introduced on May 19, 1930, and referred to the Committee on Merchant Marine and Fisheries. No report was made on the resolution by the committee. This resolution provided for the transfer of the functions of the radio division of the Department of Commerce to the Federal Radio Commission.

House bill 12948, transferring the functions of the Federal Radio Commission to the radio division of the Department of Commerce, was introduced June 13, 1930, and referred to the Committee on Merchant Marine and Fisheries.

On April 18, 1929, Senate bill 6 was introduced. This bill provides for the regulation of the transmission of intelligence by wire and wireless; the creation of a commission on communications to take over the present duties of the Federal Radio Commission, the radio division of the Department of Commerce, and related duties now under the jurisdiction of the Interstate Commerce Commission. This measure was referred to the Committee on Interstate Commerce, where extensive hearings were held. As a result of these hearings the provisions of this bill are now being revised.

RADIO INSPECTION SERVICE

Although greater demands are made upon this service each year and the surveys require more time because of the larger and more complicated radio installations on ships, the percentage of inspections as compared with clearances has not diminished. In 1926

there were 13,009 clearances and 9,197 inspections. In 1929 there were 15,023 clearances and 10,715 inspections. In 1930 there were 15,595 clearances and 11,334 inspections. As the radio installations on the ships included in the above figures are required by law as a safeguard against loss of life, a larger percentage of inspections should be made. The estimates for the 1932 appropriation will provide for the establishment of inspection offices at the following ports: Miami, Fla.; Savannah, Ga.; San Juan, P. R.; and Galveston, Tex., from which ports a considerable number of ships are clearing without inspection. During the last fiscal year new offices were established at Portland, Oreg., and Denver, Colo. It was planned to establish new offices in Hawaii and Alaska this year, but this may not be possible because of the increasing work at existing offices.

Of the 2,173 American vessels equipped with radio, only about 10 per cent of them come under the provisions of existing law, the remaining 90 per cent, which are voluntarily equipped, should receive more inspectional attention. Inspections developed 382 defects in the radio installations on ships during the year and these were remedied before the vessels departed. During the previous year there were 335 such defects reported.

Examinations were given 5,363 applicants for commercial operators' licenses and 3,993 applicants for amateur operators' licenses as compared with 3,477 commercial operators and 3,173 amateur operators during the previous year. There were 1,287 inspections made of ship stations for license as compared with 1,102 the previous year. Inspection of land stations during the past two years increased from 1,154 to 1,897. Inspections were made of 251 amateur stations as compared with 229 the previous year.

Undoubtedly more attention should be given to the inspection of broadcasting and other stations on land. Such inspections would develop much information of value to the Federal Radio Commission to guide it in determining its action on applications for renewal licenses, hearings, etc. Many of the unlicensed stations reported to be in operation would be discovered during these inspections, and other violations might be detected. This extension of activity will necessitate increased personnel. It is obviously not possible to accomplish this with the present force, which has worked 10,003 hours overtime during the past year.

During the year 1929, 1,075 inspection trips were made and 372 cities visited, while in 1930, 1,577 inspection trips were made and 534 cities visited.

RADIO TEST CARS

PURCHASE OF ADDITIONAL CARS

Orders have been placed for two additional test cars for use in the Boston and Seattle districts. When they are delivered each district, with the exception of New York, will be supplied with a test car. As a result, much radio-inspection work which would be impossible of accomplishment can be performed expeditiously and efficiently. Some years ago almost all of the radio-inspection work was centered around the large seaports. To-day it extends to every city of importance and many of the small towns throughout the country. This wide distribution of activity necessarily requires a

larger force of inspectors, better traveling facilities, and transportation of more apparatus. The use of test cars materially aids in coping with the increasing demands made upon the division.

MOBILE STANDARDS ON RADIO TEST CARS

Owing to the large number of broadcast and other stations sharing channels of operation throughout the United States, very serious heterodyne interference is constantly experienced. With many stations operating on the same channel, it is obviously not possible to make measurements of frequency at remote points on any of these stations. In order to handle such a situation, the six radio test cars in service are being equipped with mobile secondary standards of frequency. The cars will travel continually through the districts, measuring the frequencies of the stations that are of low power and are on heterodyne channels. In this way it is hoped to reduce materially the interference experienced on national and regional channels in the broadcast band, and to make sure that stations remain within their assignment.

It is expected that all of the mobile units will have been installed and will be in operation by November 1.

FIELD-STRENGTH WORK

The radio test cars are equipped with field-strength measuring apparatus. During the past year there were a number of field-strength studies made on radio broadcast and other types of transmitting stations. These studies were made to determine the reliable service area about the station and whether the station was using the amount of power authorized by the Federal Radio Commission. With this apparatus it is possible to measure the power of a transmitter without going to the station to make an inspection.

During the past year a number of studies were made with the field-strength sets on the test cars to determine the ratio of signal strength between harmonics and the assigned fundamental frequency. Several such studies were made for Government agencies to determine whether the transmitting apparatus they were planning to purchase complied with the specifications covering the amount of permissible harmonic energy radiated.

It is believed that if the power of broadcast stations were assigned on the basis of field-strength studies considerable good would result, and in many cases the power of stations might be increased or reduced with beneficial results to the public. During the coming fiscal year it is planned to survey many of the broadcast stations and to make measurements of parasitic radiations which are known to be causing serious interference with high-frequency stations.

MONITORING BROADCASTING STATIONS

Monitoring work during the past year has been confined almost entirely to broadcasting stations. The apparatus in use, which was designed and built by men in the service, has a limited frequency range which does not extend much above or below the broadcasting band—550 to 1,500 kilocycles. During the year 45,695 frequency measurements were made. Of this number 44,923 were of broadcasting

stations, 302 of stations other than broadcasting, and 470 of stations in foreign countries. The number of stations involved in these measurements were 380 broadcasting, 174 other than broadcasting, and 30 foreign stations. There were 1,020 measurements made showing deviations of 500 cycles or more from the frequency assigned to the stations. Of this number there were 344 measurements showing deviations from 1,000 cycles to 5,000 cycles, 16 measurements showing deviations from 5,000 cycles to 10,000 cycles, and 22 measurements showing 10,000 cycles or above. Last year 22,450 measurements were made and of this number there were 2,451 deviations of 500 cycles or more. This marked improvement in frequency stability is evidence of the efforts being made by station operators to improve the efficiency of their stations in this respect, together with the increased monitoring work done by the field force.

During the coming year the new monitoring apparatus will be in use. Then it will be possible to measure all the usable frequencies and a much greater number of stations. To get full benefit of this new apparatus and to meet the demands made for measurements of commercial and Government stations, a considerable increase in personnel is essential.

CONSTANT-FREQUENCY MONITORING STATION

For a number of years supervisors of radio have been seriously handicapped in the work of enforcing the radio-communication laws, and in many cases have been unable to carry out the requests of the Federal Radio Commission, due to the lack of proper apparatus, or due to the lack of apparatus capable of measuring the frequencies of transmitting stations with a high degree of accuracy. With the apparatus in use in the past there was always some doubt as to just what degree of accuracy of measurement was obtained, and it was difficult, if not impossible, for the various offices to check their measurements with one another. This condition led to a survey by the supervisor of radio at Detroit, Mich., of the methods used in making highly accurate frequency measurements. The views of many of the foremost radio engineers were obtained.

It was determined that the proper method to pursue in monitoring all classes of radio-transmitting stations in the United States and its possessions was to erect, somewhere in the approximate geographic center of the country, buildings in which to house the delicate frequency-measuring apparatus, and the sensitive radio receivers. It was essential that this site be well removed from manufacturing centers, telephone and telegraph lines, high-voltage transmission lines, and other possible sources of interference with reception. A site approximately 7 miles west of Grand Island, Nebr., comprising 50 acres of land in the form of a square, was finally obtained, without cost to the Government. The selection of this site was made only after careful investigation of reception conditions in the States of Kansas, Missouri, Nebraska, Iowa, and Illinois. At this location there is little or no man-made interference, and stations in foreign countries, as well as transmitting stations in continental United States, were regularly received without difficulty.

The 50-acre site selected is a quarter of a mile north of the Lincoln Highway, on level, sandy, prairie land. There are no telephone,

telegraph, railroads, power lines, or residences within 3 miles of the site.

In addition to the two buildings it was necessary to install a sewage-disposal system, a water-supply system, and an electric-light plant. Fear was felt that through use of local power lines interference from devices operating on the power line many miles away would be conducted onto the reservation and picked up by the receivers. In investigating many of the complaints in 1927 it was found that inductive interference on high-voltage power lines was frequently carried 75 or 100 miles. With a local power plant and the placing of all power and telephone cables underground adequate protection against this type of interference is assured and the station is entirely independent of any outside source of power.

To be assured of 24-hour reception every month in the year special antennæ were constructed for the reception of all radio stations operating between the frequencies of 60,000 and 10 kilocycles. These special antennæ were necessary so that measurements could be made when static during the summer season was especially severe, and when, with an ordinary type of antennæ it would be impossible to do frequency-measuring work. Four antennæ of the multiple-doublet type were erected on the reservation and cover the high-frequency bands. This type of antenna is especially directive. They were so arranged that two of them point to London, England, for use in the reception of high-frequency stations in eastern United States and Europe, and two similar antennæ are pointed to Porto Allegro, South America, for the interception of high-frequency stations in southern United States, Central America, West Indies, and South America.

For the reception of broadcast stations and other services operating within the intermediate-frequency bands, a special antenna of the directive type, known as a "Beverage" was erected. This antenna points to New York City and is intended to receive broadcast and other stations in the United States. Later it is hoped that a similar type of antenna can be erected pointing in a westerly direction to San Francisco for the interception of broadcasting and other stations on the west coast. In addition to the antennæ just described, four single doublets, one vertical, and one general purpose antennæ were constructed for general all-around reception. It was not intended that they would have any highly directive properties. These antennæ are for the interception of high-frequency stations. For the interception of signals on frequencies between 200 and 10 kilocycles two large loops, at right angles, 250 feet long and 40 feet high, on a side, were erected. With this loop it is intended that reception of low-frequency stations throughout the United States and the world will be possible.

All antennæ referred to above are suspended on 60-foot cedar poles, and all—excepting the loop and general-purpose antennæ—are located a considerable distance from the buildings, out in the open. Signals are brought from these antennæ to receivers through long, 4-wire transmission lines which have been especially constructed with great care and precision.

Temporary power facilities in the form of three 2-kilowatt Kohler lighting plants were arranged for with the airways division of the Bureau of Lighthouses. With this temporary power equipment in position for service, it was possible to begin the installation of the radio

receivers, storage batteries, standards of frequency, and other equipment. This work has been pressed as rapidly as possible, and the receiving equipment is now 80 per cent installed.

The apparatus installed consists of one standard of frequency having an accuracy of one part in a million, and one secondary standard having an accuracy of one part in a hundred thousand. In addition to these two standards there are, at the present time, a total of five receivers. Two of these receivers operate on a frequency of 30,000 to 1,500 kilocycles, two operate on frequencies from 1,500 to 100 kilocycles, and one receiver operates on frequencies from 100 to 10 kilocycles. With these receivers it will be possible to measure all of the usable radio frequencies in the spectrum.

During tests of the apparatus while being installed, over 300 broadcast stations were received, as well as a number of other services in continental United States. In addition to this, reception of stations in Chile, Canada, Cuba, Portugal, France, England, Philippine Islands, Hawaii, Argentine, Peru, Netherlands, Brazil, Panama, Costa Rica, Nova Scotia, Russia, and many other places in the world are regularly recorded.

The monitoring of stations operating on the frequencies which can be measured by this station will cover the following classes of service: Transoceanic; telegraph and telephone; marine, operating on high, low, and intermediate frequencies; marine coastal; aircraft; aircraft ground stations; various point-to-point services; broadcasting; amateur; television; and facsimile.

The two buildings are of brick and concrete construction, and were finished and finally accepted by the Government in March of this year. Efforts are being made to have the station in full operation by November 15, 1930.

SECONDARY STANDARDS OF FREQUENCY

To supplement the frequency-measuring work to be done by the station at Grand Island, Nebr., nine secondary standards of frequency stations are being installed at the following places: Boston, Mass.; Baltimore, Md.; Atlanta, Ga.; New Orleans, La.; Los Angeles and San Francisco, Calif.; Portland, Oreg.; Chicago, Ill.; and Detroit, Mich. While these secondary standards of frequency will have neither the range nor the accuracy of the station at Grand Island, with them it will be possible to monitor or measure the frequency of many of the stations in those particular areas.

The apparatus at the office of the supervisors of radio at Boston, Chicago, and Baltimore are installed and in operation. The installations at Detroit, Atlanta, and New Orleans will be completed within the next 60 days, and by November 1 all of the secondary standard installations at the places enumerated above will be installed and in operation.

RADIO FOR AVIATION

During the past year considerable thought has been given to types of radio apparatus suitable for use on airplanes and the qualifications which should be possessed by radio operators on planes.

Several of the air transport companies have established and operate their own two-way communication service between ground and

plane along their respective routes. Licenses have been issued to 66 aeronautical stations and construction permits have been issued for 23 more which will make 89 aeronautical stations in operation within a short time. Last year there were 97 planes equipped with apparatus not including planes of the Army and Navy. Now there are 215 planes so equipped.

In order that life may be properly safeguarded the radio apparatus on passenger-carrying planes should receive the same attention as is now given to the radio equipment on merchant vessels.

RADIOBEACONS AND RADIO COMPASSES

Installation of radiobeacons and radio compasses continues to increase. There are in operation now 26 radiobeacons on the Atlantic coast, 18 on the Pacific coast, 7 on the Gulf coast, and 29 on the coast of the Great Lakes, a total increase for the year of 15. In other countries there are a total of 80 beacons, as compared with 57 the previous year.

Radiocompasses are now in use on 832 commercial vessels under the United States flag, an increase of 114 during the year, and on United States Government vessels there are now 436 as compared with 375 last year, making a total of 1,268 on vessels of the United States. There are 2,285 foreign vessels so equipped as compared with 1,942 last year.

AUTOMATIC ALARM SIGNAL DEVICE

During the year 755 inspections were made of vessels equipped with automatic alarms which are being used on foreign vessels, mostly British. Reports were made to the division that the device had responded 1,210 times to signals not intended to actuate the apparatus.

Last year the Coast Guard purchased two sets of this apparatus. Arrangements are being made to install one of these sets on a vessel on the Great Lakes where it can best be subjected to practical tests to determine its efficiency.

The Radiomarine Corporation is developing an alarm device which it is hoped will be ready for practical tests on the Great Lakes before this year's navigation season closes.

RADIO COMMUNICATION

During the year there has developed an increased demand for additional radiotelephone facilities both for international communication between this country and Europe and for communication with ships. The latter is a new service which, according to present indications, will grow to a considerable extent. Large ocean liners are now being equipped with radiotelephone apparatus as an additional convenience for the ocean traveler. Such equipment provides a means for conversation from ship to ship or ship to home or office on land.

POLICE RADIO

There is an increasing realization of the value of radio as used in connection with police work, both State and municipal. New York

City obtained a limited commercial station license in 1920 which authorized emergency communication with the police-patrol boat. Since early in 1922 the Pennsylvania State Police Department has made use of radio for quick point-to-point contact and later broadcasting police information. The Detroit Police Department used a broadcasting station as early as 1922. Since 1925 Dallas, Tex., has used a broadcasting station for contact with both the police and fire departments. In 1929 there were 12 police-broadcasting stations. There are now 20 such stations licensed; construction permits have been issued for 25 more, and 3 applications for construction permits are pending.

AMATEURS

After 18 months' operation under the restricted wave bands imposed by the Washington treaty of 1927, the amateurs are operating as satisfactorily as could be hoped for, considering the great number of amateur stations in these narrow bands. This is due, for the most part, to improved technical methods and apparatus devised particularly to meet the new conditions. Amateurs show increasing technical skill. Amateur voice transmission on high frequencies was given impetus by the opening of the band from 14,100 to 14,300 kilocycles for telephony as well as telegraphy. Numerous stations have effected satisfactory international telephony. Many of the better radiotelegraph stations have been in communication with upwards of 70 countries. There is an increasing interest in the investigation of the communication possibilities of the ultrahigh frequencies above 28,000 kilocycles.

Amateurs of the United States have long been noted for their excellent self-policing. In this connection it is interesting to note the establishment of an organized nation-wide, standard-frequency system to make available to amateurs, both in this country and abroad, calibration signals of known frequency, to aid amateur stations in keeping within their allotted bands. Three stations, transmitting on regular schedules, have been set up in laboratories at South Dartmouth, Mass., Elgin, Ill., and Los Angeles, Calif. The Elgin and Los Angeles installations are equipped with secondary-frequency standards checked by the Bureau of Standards; the South Dartmouth installation possesses a primary standard. The American Radio Relay League states that all transmissions are accurate to more than 0.01 per cent; measurements of the South Dartmouth transmissions indicate an accuracy for that station of approximately 0.001 per cent. This standard-frequency system is part of a program instituted by the league for an increased appreciation of frequency precision and accuracy of control by amateur operators; its good effects are already apparent.

Amateur cooperation with expeditions continued on an increased scale; there were also additional instances of cooperation with civil authorities in local storm emergencies. The pursuit of amateur radio continues to constitute a valuable training school for skilled radio personnel for industry and the art generally. The amateurs' record of public service, their spirit of cooperation, and their demonstrated national value have continued to justify the policy of this Government toward them.

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During the year there was an increase of 2,165 amateur stations. This is the largest year's increase since 1922. Last year there were 16,829 licensed amateur radio stations. There are now 18,994. In 1920 there were 5,719 amateur stations.

PERSONNEL

The division's personnel is inadequate to perform promptly and completely the duties imposed upon it. For the next fiscal year a larger appropriation is being requested to remedy this condition. In the field force there are 9 supervisors, 68 inspectors, and 57 clerks assigned to 20 offices. Estimates for next year contemplate the employment of 9 supervisors, 121 inspectors, and 75 clerks, and the establishment of 6 additional offices.

INTERNATIONAL CONFERENCES

The International Radiotelegraph Convention of Washington, 1927, established an international technical consultative committee for radio communications for the purpose of studying technical and related questions having reference to these communications. Its function is limited to giving opinions on the questions submitted by the participating administrations or private enterprises and to which it has given study. The first meeting of this committee was held at The Hague, Netherlands, in September, 1929, and was attended by representatives of the United States. Preparations are being made to submit proposals for consideration at the next conference to be held at Copenhagen, Denmark, May 26 to June 6, 1931.

The International Radiotelegraph Bureau at Berne, Switzerland, has notified all administrations to prepare propositions concerning the International Radiotelegraph Convention and the two sets of regulations (general and additional) annexed thereto, in preparation for the conference to be held in Madrid, Spain, in 1932.

INTERNATIONAL RADIO ACCOUNTING

The activities of the accounting section of the radio division in the settlement for international radio tolls during the fiscal year may be summarized as follows:

Number of accounts handled:	
On hand July 1, 1929	756
Received during year	924
Total	1,680
Settled and cleared	1,111
Accounts on hand and unsettled June 30, 1930	569
Financial operations required to complete activities summarized:	
Cash balance July 1, 1929	$44,519.81
Collections during fiscal year of 1930	83,343.26
Total	127,863.07
Disbursements during fiscal year of 1930	86,912.24
Cash balance, June 30, 1930	40,950.83

It will be noted that while there was a decrease of 176 in the number of accounts received during 1930 over 1929, there was an increase of 66 in the number of accounts settled and cleared. Certain countries agreed to combine into single documents accounts which formerly, without advantage, had been rendered separately. During earlier years, delinquent administrations frequently rendered accounts covering as many as 18 or 20 months, but now accounts are submitted with sufficient regularity to assure that the maximum number of accounts received from one country at no time exceeds 12 during the year, or one for each month's traffic. The increase in the number of accounts settled and cleared is due to improved methods which made it possible to adjust all accounts of long standing. Of the 569 unsettled accounts on hand, 330 are ready for settlement and will have been cleared from the records by August 30, 1930.

Very truly yours,

W. D. TERRELL,
Chief, Radio Division.

BUREAU OF THE CENSUS

DEPARTMENT OF COMMERCE,
BUREAU OF THE CENSUS,
Washington, July 1, 1930.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: I submit the following report of the work of the Bureau of the Census during the fiscal year ended June 30, 1930.

INTRODUCTION

It is naturally a great satisfaction to be able to report that the task of taking the Fifteenth Decennial Census of the United States has been successfully completed. One can safely say that it has been the most comprehensive statistical survey ever undertaken by this or any other nation, whether measured by the scope and detail of the inquiries, or by the number of persons employed on the work, or by its cost, or by the mass of data which it has accumulated.

The population enumerated in this census, covering continental United States and all outlying territories and possessions except the Philippine Islands, is approximately 125,000,000; and the territory covered is about 3,628,000 square miles.

The "taking" of the census, as the term is here used, covers the collection of the basic data—the securing of the answers to numerous inquiries relating to individuals, farms, factories, mines, and trading, and other enterprises, covering the subjects of population, agriculture, manufactures, irrigation, drainage, distribution, and unemployment. The bureau is now facing the task of tabulating and publishing the data, which task must be completed by December 31, 1932. There are approximately 20,000,000 schedules being handled, checked, and coded, preparatory to transcribing the data to punch cards.

At the close of the fiscal year there was a force of 5,032 employees in the bureau, compared with 925 employees on July 1, 1929. Of the present force 90 per cent are engaged on the Fifteenth Census work.

One great problem involved in the work of the bureau during the past fiscal year has been to carry on its regular periodical inquiries and at the same time detail a sufficient portion of the experienced force regularly employed on these inquiries to organize and conduct the Fifteenth Decennial Census. This has resulted in a decided reduction in the number of experienced persons employed in collecting, tabulating, and compiling the annual statistics of births, deaths, marriages, divorces, financial transactions of State and city governments, the biennial census of manufactures, current statistics of cotton ginned, active and idle spindles, and production and stocks of numerous commodities. Many of the experienced persons regularly employed on these investigations were diverted to the preliminary and

other work incident to taking the decennial census of population, agriculture, manufactures, distribution, mines, quarries, irrigation, drainage, and unemployment.

The Fifteenth Census Act, while it specified the main subjects to be covered by the census, left the question of detail to the discretion of the Director and the Secretary of Commerce under the provision that "the number, form, and subdivision of the inquiries in the schedule shall be determined by the Director of the Census with the approval of the Secretary of Commerce." The matter of adding new questions to the schedule or eliminating questions included in previous censuses is one which requires the judgment of experts and must be very carefully considered from several angles.

On this important matter of selecting and limiting the questions on the schedules the department sought the best counsel available. The subject was considered and discussed in meetings of committees of economists, statisticians, experts, and others, and also in correspondence or interviews with individual persons interested in some particular question or subject covered by the census. Advisory conferences were called by the Secretary of Commerce to consider the scope and formulation of the schedules—one conference on population, another, with a different personnel, on manufactures, a third on distribution, and a fourth on unemployment. In formulating the agricultural schedule, the bureau was in constant conference with representatives of the Department of Agriculture.

The accuracy of the enumeration as regards the count of the population and completeness of the canvass was promoted by the requirement that the local supervisors should give publicity to the total for each political subdivision; by securing the cooperation and assistance of local organizations, such as the chambers of commerce, boards of trade, and business clubs; and by investigating, as far as possible, all complaints or allegations that a defective enumeration had been made.

To prepare the people of the United States for the coming census and to inform them in regard to it, President Hoover issued a proclamation announcing the taking of the census, reminding the people that it was their duty under the law to answer the census questions and assuring them that the data would be used for statistical purposes only and that no disclosure would be made regarding any individual person or his affairs. The proclamation was printed in 23 different languages with a total edition of more than half a million copies and was widely distributed through the supervisors and in other ways. With the cooperation of the Postmaster General it was posted in the post offices throughout the United States.

The bureau sought to avail itself of every reasonable and legitimate means of giving publicity to the census, such as newspaper articles, distribution of pamphlets or leaflets, radio talks, news reels, motion pictures, etc. A circular letter telling about the census and carrying the principal questions on the population schedule was sent to school-teachers, with the request that they explain the census to the school children.

Briefly summarized, the work of taking the census consisted in—

1. Establishing the boundaries of 575 supervisors' districts. Each district contained a territory in which a supervisor would be responsible for the enumeration of the population and the collection of the statistics of agriculture, irrigation, drainage, and any other subjects that might be assigned him.

2. Subdividing each supervisor's district into enumeration districts not too large to be canvassed by the enumerators within the time fixed by the law and the regulations of the department.

3. The formulation of the schedules of inquiries covering the subjects to be included in the census as defined by law; and the preparation of the instructions and numerous forms required for the conduct of the field force. There were more than 400 printed schedules and forms used for this purpose, with a total edition of over 67,000,000 copies, besides a large number of mimeographed letters and forms distributed to the supervisors.

4. Selection and appointment of supervisors and enumerators. Each applicant for appointment to these positions was required to fill out a schedule designed to test his qualifications for the work.

5. Distribution of blank copies of schedules and other questionnaires and instructions to the field force.

6. The holding of conferences with the supervisors. These conferences were held in the principal cities of the United States, and, for the first time in the history of census taking in this country, the Director of the Census thus came in personal contact with every supervisor.

7. Instructions on the part of the 575 supervisors to the enumerators who were appointed to make the canvass in over 120,000 enumeration districts.

8. The selection and appointment of the office force that would be required in the office of each supervisor. This force consisted of 4,302 employees.

9. Making arrangements with the Indian Bureau for the Indian agents to act as supervisors for Indian reservations.

10. Making similar cooperative arrangements with the War Department, the Navy Department, and the State Department, as well as with the Bureaus of Lighthouses, Fisheries, and Navigation of the Department of Commerce.

11. Establishing cooperative arrangements with the chambers of commerce, the boards of trade, business clubs, newspapers, and prominent citizens, throughout the United States.

12. Giving publicity to the fact that a census was to be taken and appealing to every person to cooperate with the bureau in its endeavor to make a perfect enumeration.

13. Supervising the work of the supervisors, enumerators, and agents employed throughout the United States during the enumeration which extended from April 1 to July 1.

14. Making arrangements for the announcement by the supervisors of the total population and number of unemployed in the different political subdivisons of their respective districts. This was the first time in the history of census taking in the United States that arrangements of this character have been made.

By July 1, the bureau had announced the population of 745 cities of over 10,000 inhabitants each out of a total of about 940; and of 1,821 counties out of a total of 3,098. And, of course, large numbers of smaller cities, townships, and other political subdivisions were also announced by that time. In all, the bureau made over 70,000 announcements before July 1. At the corresponding date following the census of 1920, only 221 cities had been announced and no counties.

WORK OF ENUMERATION

Establishing enumeration districts.—In the preparations for the census one of the most difficult and important tasks is the division of the territories of the United States into enumeration districts not too large to be canvassed by the enumerators within the time limit fixed by law, namely, two weeks in cities and one month in the rural districts. During the greater part of the past fiscal year approximately 250 persons employed in the bureau have been engaged in completing and perfecting the enumeration district plans.

To make sure that the districts were clearly defined, descriptions of the enumeration districts were sent to the supervisors for review, and the supervisors were authorized to visit county seats and other

places in their districts, if necessary, for the purpose of consulting with local officials in checking over the maps and description of the enumeration districts. The material was then returned to the bureau with the supervisors' comments and suggestions of changes, if any were found desirable. After further study in the bureau, the maps, descriptions of the 120,105 enumeration districts or plans of division, with the rates of pay indicated thereon as finally approved, and assignment sheets were again forwarded to the supervisors for their information and guidance in the conduct of the enumeration.

The political changes in county organization and changes of city boundaries immediately preceding and during the census made it necessary to be making changes continuously, even during the progress of the work.

The areas assigned to enumeration districts in cities were designed to be large enough to occupy the enumerators' time for about 2 weeks and to contain an average of approximately 1,800 persons. In rural areas the districts or assignments were made large enough to occupy the time of the enumerators for about 30 days. In rural sections the population in the average enumeration district was considerably less than 1,800, but the enumerators were required to fill out schedules for all the farms in their districts as well as for the population. The districts were laid out in such fashion that even the smallest incorporated place formed an enumeration district by itself, this plan having been followed in order to make sure that separate returns would be made for the population of every incorporated place, no matter how small. The territory outside the incorporated places was likewise so divided that every township or "balance of township" formed one or more enumeration districts, and in no case were parts of two townships placed in the same enumeration district. Where the enumeration districts were very small, the supervisor was permitted to assign two or more districts to the same enumerator, the bureau having suggested to each supervisor certain combinations of districts that might conveniently be made.

Large institutions, such as prisons, hospitals, etc., were made separate enumeration districts and were enumerated in most cases by employees of the institutions. In a few of the larger cities, apartment houses having 100 or more apartments were made separate districts and were handled in the same way as the larger institutions. Military posts and naval stations likewise were generally made separate enumeration districts, and officers and enlisted men were appointed as the enumerators.

Appointment of supervisors.—In 1920 the number of supervisors' districts was 372. The average population of the district was 284,168, and each supervisor, on the average, had charge of 234 enumerators. It was thought that to get the best results the supervisors' districts should be reduced in area and in population. Accordingly, the number of supervisors' districts at this census was increased to 575; giving an average population of 213,388 per district with an average of 208 enumerators.

The country was divided into supervisors' districts of appropriate size as regards population and area with headquarters located in cities, which, from the standpoint of transportation facilities and accessibility to all parts of the districts, were considered the most convenient points from which to supervise the enumeration.

As soon as the boundaries of a supervisor's district had been decided upon and the headquarters fixed, the bureau proceeded with the appointment of the supervisor, limiting the choice to persons resident in or near the city in which the headquarters were established. Each candidate was required to fill out an application blank giving his (or her) business training, and other data indicating qualifications for supervisory work such as that required of a census supervisor; and in order that the applicant, before accepting the appointment, might be fully informed of the practical nature of the duties, each candidate was required to fill out the population test schedule (also in rural sections, the agricultural test schedule), and to read the pamphlet, Instructions to Supervisors, which outlined the procedure to be followed at the various stages of the field canvass.

The total number of supervisors appointed, exclusive of those selected for special service, was 575, which included 30 women as compared with 5 women employed as supervisors at the 1920 census.

A supervisor for Indian reservations was especially appointed for supervising the enumeration of Indians; and wherever the best results could be obtained through cooperation with the Office of Indian Affairs employees of that service were appointed as local supervisors and enumerators. There were 39 Indian agents employed on this work, and their services were eminently satisfactory. They collected not only the statistics required for the census of population, but also those for the censuses of agriculture, distribution, manufactures, irrigation, and drainage, wherever advisable. The Indian Bureau cooperated very effectively with the Census Bureau, and the general impression is that this cooperation has resulted in a more complete enumeration of the Indians on reservations than at any preceding census. Special efforts were also made to enumerate the Indians not on reservations, and statistics will be compiled to show the total Indian population of the United States.

Securing quarters and equipment.—The supervisor was instructed to secure, without cost to the bureau, through cooperation with the local Federal Business Association, adequate quarters and office equipment if available from any Federal, State, county, municipal office, or civic organization, such as chambers of commerce, boards of trade, etc. From one or more of the sources referred to the supervisors in 346 districts were able to secure without cost to the bureau the space required, and in 141 districts all of the equipment needed. In 229 districts it was necessary to rent quarters, and for 434 districts the bureau was obliged to rent or purchase the equipment or portions thereof.

Handling correspondence.—The establishment of supervisors' and enumerators' districts, determination of enumerators' rates of pay, preparation of instruction of supervisors and enumerators, shipment of schedules, forms, and stationery, and the numerous other details required for organizing and providing with the necessary quarters, office equipment, and supplies, the large field force needed for the census of population and agriculture involved a large volume of correspondence with the supervisors and others. This correspondence reached its greatest proportions between December 1, 1929, and May 31, 1930, during which period the bureau dispatched 56,284 type-

written letters, 6,598 telegrams, and 411,887 multigraphed letters and other forms, or a monthly average of 79,128 letters, telegrams, and forms, equivalent to a daily average of about 3,000.

Shipping schedules.—All schedules, blank forms, and supplies needed by the supervisors were mailed in packages and wooden boxes, as conditions required, the boxes being retained by the supervisors and used for the return of the completed schedules to the bureau. The total number of separate shipments, the greater portion of which were mailed during the months of February and March, was 29,211, and consisted of 119,145 packages and 10,792 boxes. These shipments required the use of 480 reams of wrapping paper, 4½ tons of twine, and 9,000 mail sacks. The quantity of the principal schedules mailed to the supervisors was as follows:

Population	2,673,399
Agriculture	10,512,410
Unemployment	599,038
Incidental livestock not on farms	489,930
Special fruits and nuts	922,429
Irrigation No. 1	309,138
Supplemental, blind and deaf mute	284,273
Supplemental, Indian population	355,550
Total	16,146,167

Office force for supervisors.—For each supervisor's district the bureau authorized the appointment of one chief assistant, one stenographer, and one general office clerk. These appointments were not made generally until February or the first part of March, but in some districts the supervisors found that there was a considerable amount of work to be done at an earlier date, especially in connection with handling applications for appointment as enumerators. In these cases the bureau, upon request of the supervisor, authorized the employment of such stenographic and clerical assistance as was deemed necessary, and fixed the pay at hourly rates, the total compensation being usually limited to the sum of $100. There were 71 supervisors' clerks appointed for temporary service on this basis with compensation ranging from 25 cents to $1 per hour when actually employed.

The office clerks were appointed at per diem rates for time actually employed, and as a rule the chief assistant was appointed at $6 per diem, the stenographer at $5 per diem, and the general office clerk at $4 per diem. Exceptions to these rates were made in certain large districts or districts in which conditions were unusual; and where the number of enumerators employed in a supervisor's district was very large, or where other conditions made the work especially difficult, additional assistants and clerks were authorized. Employment of extra help as a rule was limited to a period of about 10 days during the actual enumeration.

The number of supervisors' clerks employed at the peak of the canvass was approximately 3,000, and the total number appointed was 4,302, with compensation ranging from $2.50 to $10 per diem, when actually employed. In addition to the clerks, it was necessary to appoint 99 janitors and other subclerical employees for some of the districts. These subclerical employees were appointed at varying rates of compensation.

Appointment of enumerators.—A fixed rate of pay was allowed the enumerator for each person reported on the population schedule and for each farm on the agricultural schedule. The rates of pay were determined by the bureau after a thorough study of population density, farm density, and transportation, with due regard for the length of time required. The usual rates were 4 cents or 5 cents for each person enumerated and 40 cents or 50 cents for each farm, but under exceptional conditions rates as high as 20 cents per person and $5 per farm were authorized. The rates were intended to be high enough to enable an enumerator of average industry to earn from $5 to $8 per day during the period of the enumeration. Flat rates of pay were established for special schedules as follows: 2 cents for each person enumerated on the unemployment schedule, 2 cents for each person enumerated on the blind and deaf mute schedule, 5 cents for each place reported on the schedule for incidental agricultural production and livestock, 10 cents for each special fruits and nuts schedule, and 10 cents for each irrigation and drainage schedule.

The enumerators were appointed by the supervisors in conformity with the provision of the census act permitting the Director of the Census to "delegate to the supervisors authority to appoint enumerators." General instructions with respect to the qualifications of applicants and for filling out the appointment certificates, oaths of office, vouchers and other forms required, were contained in the pamphlet Instructions to Supervisors, supplemented from time to time by special instructions. To assist the supervisors in the selection of competent persons as enumerators, a test was prescribed for applicants, who were permitted to take such tests at their own homes. This test consisted of filling out, in addition to an application blank with questions concerning the applicant's personal characteristics, education, training, and experiences, a population test schedule, and also, in rural districts or districts in which there were likely to be 10 or more farms, an agricultural test schedule. The facts to be entered on the test schedule were supplied in the form of a narrative descriptive of the families and farms in a hypothetical community. One incidental advantage of the test was that it made it reasonably certain that each person appointed as enumerator had studied the instructions, since no one could fill out the schedule satisfactorily without carefully studying the instructions for taking the census as supplied to each candidate.

Prior to March 1, the test schedules were mailed directly to the applicants from the bureau and were returned to and graded in the bureau. Lists of candidates who made a satisfactory showing were sent to the supervisors, together with the applications and test schedules as filled out and rated. During the month of March, however, on account of the nearness of the census date, it was necessary for the supervisors to examine the applications and rate the test schedules filed with them.

The total number of enumerators' applications with test schedules mailed out by the bureau, the number returned by applicants, and the number rated as satisfactory were as follows: Applications with population test schedules mailed out, 336,891; agricultural test schedules mailed to applicants in rural sections, 85,156; population test

schedules returned to the bureau by applicants, 197,952; agricultural test schedules returned to bureau, 39,250; population test schedules rated as satisfactory, 157,016; agricultural test schedules rated as satisfactory, 37,378.

For districts in which there were a considerable number of foreigners not able to speak English it was sometimes necessary to employ interpreters to assist the enumerators. There were 291 interpreters appointed, with rates of pay varying from 40 cents per hour to $10 per diem.

Instructing supervisors and enumerators.—Instructions for carrying out the numerous details connected with the enumeration and for securing complete and accurate answers to the questions on the different schedules were carefully worked out in advance and were contained in the printed pamphlets Instructions to Supervisors and Instructions to Enumerators. These instructions were supplemented from time to time, as the work progressed, by written instructions relative to specific features of the canvass. Oral instructions were also given the supervisors at conferences between them and the Director of the Census, held during the months of January, February, and March in the following cities: Washington, D. C., New Orleans, Dallas, Los Angeles, San Francisco, Seattle, Helena, Minneapolis, Omaha, Denver, Kansas City, Mo., St. Louis, Chicago, Atlanta, Memphis, Cincinnati, Detroit, New York, and Boston. With one exception, all the supervisors attended some one of these conferences.

Payment of field force.—To facilitate payment of the compensation of supervisors' clerks and enumerators during the period when the field work reached its maximum proportions, special disbursing agents were designated with headquarters at Chelsea, Mass.; Charleston, S. C.; New Orleans, La.; Dallas, Tex.; Chicago, Ill.; Milwaukee, Wis.; St. Louis, Mo.; Salt Lake City, Utah; Portland, Oreg.; and San Francisco, Calif. Six of these disbursing agents were superintendents of the Lighthouse Service, and four were regular employees of the Bureau of the Census. Pay rolls for the supervisors' clerks and vouchers for enumerators for all supervisors' districts in 34 States and for 2 supervisors' districts in Michigan, were paid by these special disbursing agents. The pay rolls and enumerators' vouchers for all other districts, as well as all vouchers for purchases, rentals, and expense accounts of the supervisors for all districts, were paid from Washington by the disbursing clerk of the Department of Commerce.

Announcing population.—Upon completion of the enumeration in each district, the supervisors were required to have a careful examination of the schedules made in order that corrections might be made and omissions supplied, if required, before the schedules were forwarded to the bureau.

The population of each county, city, ward, town, village, and township or other civil division, and the number of farms, was announced by the supervisors before the schedules were sent to Washington, in order that the returns might be made available to the public at an early date and that any complaints or criticisms might be investigated by the supervisors while the schedules were still in their possession and before the enumerators had been paid off and discharged.

In these preliminary announcements the 1920 population returns were also given for all areas for which comparable figures were available, so as to show the change in population during the decade.

Cooperation with other Federal bureaus or departments.—Arrangements were made by the bureau for enumerating, through cooperation with other bureaus, persons who could not readily be reported by the regular enumerators; and where employees of the Department of Commerce and other branches of the Federal service were employed and were required to devote a considerable portion of their time to securing the data, such employees were appointed, in accordance with authority contained in the census act, as supervisors, supervisor's clerks, and enumerators, and were compensated for the service they rendered to the Bureau of the Census.

Employment of letter carriers.—It has been suggested at each census from 1880 to 1930 that the letter carriers should be used to take the census of population. This is the first time that the law permitted the employment of letter carriers for this purpose. A number of them were appointed as enumerators, and their work developed many reasons why their services could not be satisfactorily utilized. Among them was the fact they could not enumerate the population on the regular schedules by enumeration districts in the order that they have been enumerated for many censuses.

The letter carriers employed in the District of Columbia secured individual returns. These returns had to be copied on the population schedules by clerks in the office. This not only added very materially to the cost, probably doubling the amount paid the enumerators in the other districts in the District of Columbia, but it gave rise to the usual errors made in copying.

Field work of the census of distribution and manufactures.—The field work in connection with the census of distribution, manufactures, and mines and quarries was carried on by the same personnel under the direction of the field division of the Bureau of the Census. The supervisors of the population census had charge of collecting returns for these inquiries in rural districts and in all cities and towns which had a population of less than 250,000 in 1920. They were authorized to employ the necessary number of special enumerators to collect returns from the distributors, manufacturers, and operators of mines or quarries, and to divide the territory for this purpose into enumeration districts considerably larger than the districts assigned the population enumerators. The method of canvass was approximately the same; that is, the enumerators were required to make a personal canvass in the commercial or industrial areas. In cities of over 10,000 population the enumerators were paid a per diem rate, usually $4, for days actually employed. But in smaller cities and country districts they were paid a fixed rate, usually 50 cents for each schedule returned. In cities having a population over 250,000 the work was made under the supervision of experienced and trained employees of the Census Bureau, detailed from the Washington office, to take sole charge of the enumeration within the cities to which they were sent and at the same time to instruct the population supervisors and the special enumerators in regard to the conduct of the work in the surrounding territory.

The personnel used in taking the census of distribution comprised 75 chief special agents, 509 supervisors of the population census, and

approximately 8,000 special enumerators. Returns were obtained for approximately one and three-quarters million wholesalers and retailers, and one-quarter million manufacturing establishments, mines, and quarries.

Census of outlying Territories and possessions.—The census of population and of agriculture for Alaska, Hawaii, Porto Rico, Virgin Islands of the United States, Panama Canal Zone, Guam, and Samoa were made to conform, in a general way, to the census on these subjects for continental United States. The census date was April 1, 1930, except for Alaska, where the census was taken as of October 1, 1929, on account of climatic conditions. The total number of enumeration districts in these Territories and possessions was approximately 1,700.

CENSUS OF POPULATION

One of the most important tasks accomplished during the fiscal year was the determination of the form of the population schedule to be used for the Fifteenth Decennial Census. Numerous suggestions for additions and changes were received. They numbered about 40, though perhaps not more than 12 or 15 were such as to warrant serious or extended consideration.

A committee of 16 members met at the invitation of the Secretary of Commerce to discuss various questions involved in the formulation of the 1930 population schedule, including most of the suggestions noted above. As a result of the recommendations of the special population committee and of extended discussion by members of the staff of the Census Bureau itself, the 1930 schedule was finally established.

One of the greatest difficulties of the census of population is that of enumerating people at their residence or "usual place of abode." An absent-family schedule was provided for the enumeration of families temporarily away from their usual place of residence at the time of the census, the idea being that this schedule would either be filled out by such families prior to their departure if they were leaving shortly before April 1 or, if they had already gone and their temporary address was known, would be mailed to them to be filled out and returned by mail to the local supervisor.

As a counterpart to the absent family schedule the bureau devised a nonresident family schedule. This was to be used where families were found temporarily residing in a locality but claiming permanent residence elsewhere. These schedules were sent directly to Washington, where they were allocated to the city or other locality which the family claimed as its place of residence.

Something over 10,000 of these nonresident family schedules were turned in, representing about 22,000 names. Of the 17,000 names thus far checked from these schedules, about 15,000 have been added to the population of the places which they claimed as their usual places of residence and about 2,000 were found to have been already enumerated there. This is the first time in the history of the census that this plan for transferring nonresidents to their usual place of residence has been applied. It is of interest to note that about 45 per cent of the nonresident schedules were received from two States—California and Florida.

CENSUS OF UNEMPLOYMENT

The first formal conference on the subject of the unemployment schedule was held on July 3, 1929, on which date 12 persons representing various organizations and interests were called together for this purpose by the Director of the Census. On July 15 a more extensive committee, comprising 22 members, met at the Department of Commerce on the invitation of the Secretary, and discussed a tentative form of the special schedule for unemployment which had been drawn up for the occasion.

The unemployment schedule as finally made up was divided into two main sections, one containing inquiries with regard to persons who were reported as entirely out of a job and another for persons who were reported as having a job but for some reason not at work on the day preceding the enumerator's call. Inquiries were made of both classes as to how many weeks the person had been idle and as to the reason for not being at work. Provision was also made on the schedule for the transcription of information as to sex, color, nativity, age, marital condition, occupation, etc., from the regular population schedule.

CENSUS OF AGRICULTURE, 1930

For 90 years a census of agriculture has been taken in connection with the decennial censuses, beginning with a small number of questions on a single schedule in 1840 and developing into a number of schedules containing a multiplicity of questions. A mid-decennial farm census was taken for the first time in 1925, having been authorized by the act providing for the Fourteenth Decennial Census, that of 1920.

In the census of agriculture, 1930, the information was returned on 16 schedules: The general farm schedule, 2 supplemental schedules for special fruits and nuts; 2 schedules for incidental agricultural production and livestock, poultry, and bees not on farms or ranges; 2 special schedules for sheep for use in 13 western States; 2 schedules on irrigation; 1 schedule on drainage, and 6 schedules on horticulture.

The preparation of the general farm schedule to be used in the census of 1930 was begun June 29, 1928. A tentative form of the schedule was prepared and copies were sent to officials of the Department of Agriculture, State agricultural colleges, and to others known to be especially interested. More than 2,000 requests for additional inquiries were received. These covered a wide range, including items of expenditures connected with farm operations, facilities and conveniences in the farm home, purchases and sales of domestic animals together with the farm slaughter and sales of hides and skins, special questions for certain crops for which separate questions had not been included in the schedule, and an insistent demand that the subtropical fruits be accorded more space than had been given to them at any previous census.

Numerous conferences were held with officials of the Department of Agriculture to determine the scope of the schedule.

A number of questions new to the farm census were placed on the general farm schedule, the more important being those calling for the value of the farmer's dwelling house, amounts expended for pur-

chase of electric light and power and purchase of farm implements and machinery, number of days in 1929 the farm operator worked for pay at jobs other than farming, number of electric motors and stationary gas engines, number of combines, and movement of farm population from city to farm and farm to city during the year, also the questions relating to value of products of the farm which were included in the final revision of the schedule.

A series of questions were included, designed to show the amount of money received from the principal classes of products of the farm, including also the value of products of the farm consumed by the farm family and the receipts from boarders, lodgers, campers, etc. The introduction of these questions laid the foundation for a classification of farms and farm data by total receipts and also a classification by type of farming as shown by the operations conducted on the farm in 1929. The official schedule for the census of agriculture in the Fifteenth Decennial Census, being the thirteenth edition of the schedule, contained 353 questions.

Sample schedules were prepared and distributed to farmers through county and State representatives of the Department of Agriculture, through the agricultural associations, and through the agricultural press. Many were sent directly from the bureau to farmers living in counties having no county agent of the Department of Agriculture, the names being secured from the farm schedules returned in the census of 1925. The bureau also supplied thousands of copies to members of Congress to distribute among their constituents. About 4,500,000 schedules were placed in the hands of farmers to aid them in making prompt and accurate replies when visited by the enumerators.

The experience of the bureau on the farm census of 1930 indicates that the schedule is too complicated. For its field work in the general census, the bureau must depend upon an army of inexperienced enumerators, hastily organized and instructed, the term of service being limited in most cases to one month. Under these conditions the farm schedule should be limited to such questions as the average farmer can answer readily.

Special fruits and nuts schedules.—To meet the demands of the growers of fruits and nuts, produced principally in California and Florida, two supplemental schedules were prepared. One of the schedules, containing 128 questions, was prepared for use in counties in California, Arizona, Idaho, Oregon, and Washington; the other schedule, containing 102 questions, was prepared for use in counties in Florida, Alabama, Louisiana, Mississippi, and Texas. Through the use of these two schedules the bureau has secured data for more extended statistics relative to the orchard fruits, grapes, subtropical fruits, and nuts of these regions than it has been possible to publish as the result of any preceding census.

Livestock and crops not on farms or ranges.—At each decennial census, beginning with that of 1900, the census of agriculture has included an enumeration of livestock not on farms or ranges, so as to cover those numerous instances in which cows, horses, and hogs are kept on premises which are not farms. At this census, this inquiry was extended to include poultry and bees; also crops of all kinds,

including fruits, vegetables, plants, and flowers, produced for sale on places that are not classified as "farms," if the amount sold amounted to $50 but less than $250 in value.

It is a somewhat difficult matter to draw the line between what is a farm and what is not. After considerable discussion, it was decided to adhere to the definition adopted at preceding censuses, under which a farm is any tract of land of 3 acres or more on which agricultural products are produced, or a tract of less than 3 acres which produces agricultural products to the value of $250 or more.

Census of sheep.—The enumeration of sheep in the Western States has always been a subject of special concern because of the difficulties encountered in locating migratory flocks and allocating them to the proper geographic units. To guard against errors of omission, duplication, or faulty allocation, the bureau, with the assistance of the representatives of the Department of Agriculture in the 13 States in which difficulties have been encountered, obtained lists of sheep owners from county assessment rolls, sanitary lists, grazing-permittee lists, and such other sources as were available. Copies of these lists, which cover 438 counties, were sent to the supervisors, who supplied enumerators with such parts of the lists as pertained to their respective enumeration districts.

Two special schedules were devised. One was an enumerator's sheep record, on which was to be briefed the data shown on the general farm schedule with a statement showing the county in which the sheep were in April 1, 1930, and the county in which they ranged during the greater part of the year. The other was a special sheep schedule to be sent to owners of sheep by supervisors in cases where the enumerator reported that he was unable to find an owner whose name appeared on the list furnished him. By means of these two schedules the State representatives of the Department of Agriculture, in cooperation with the supervisors of census, were able to render valuable assistance in allocating to proper geographic units the sheep that during the year cross county lines and State lines, discovering duplications in reporting, and securing information concerning flocks for which reports had not reached the supervisors.

Unit prices of farm products.—It has been the custom in recent censuses for the bureau to secure from the Department of Agriculture the price per established unit (bushel, pound, etc.) which was received by farmers in the several counties of the United States, these prices being used by the bureau in computing the value of crops, livestock, and livestock products, the quantity of which was reported on the farm schedule. This results in a material saving in both field and office, and is deemed to produce results as accurate as could be secured by calling for values on the general farm schedule. In continuation of this policy an agreement was entered into on August 9, 1929, between the Bureau of the Census and the Bureau of Agricultural Economics, providing that each bureau bear half the cost of securing the unit-price figures, the bureaus detailing employees and furnishing equipment and supplies. The agreement provided that the work should be completed on or before September 1, 1930.

Irrigation and drainage.—The subdivision of irrigation and drainage was organized on July 1, 1929. Index cards were written from reports received at the census of 1920 and from lists supplied by postmasters, State and county engineers, and other local officials upon request. From these index cards, lists of enterprises were prepared by counties and assembled by supervisors' districts for office and field use.

The census of irrigation is confined to 19 of the Western States. Two schedules were used in these States, one for enterprises serving less than 5 farms and one for enterprises serving 5 or more farms. Only one schedule is used in the drainage census, data on drainage being secured on it for 36 States, omitting some of the Eastern States.

Horticultural census.—As the general farm schedule did not include extensive inquiries on horticulture, the various trade organizations and others interested requested that a horticultural census for 1930 be taken by mail. Six schedules were prepared under the following titles: Florists, Nurseries, Bulbs, Seeds, Mushrooms, and Blueberries (including Huckleberries).

The Department of Agriculture has cooperated with the bureau and assisted in obtaining the names and addresses for the mailing list. The bureau has corresponded with all trade organizations using every possible channel to supplement the mailing list and has secured approximately 75,000 names of establishments to which schedules will be sent.

CENSUS OF MANUFACTURES

In preparation for the census of manufactures for 1929, the Secretary of Commerce appointed an advisory committee whose membership of 25 comprised manufacturers, economists, statisticians, students of labor conditions, and others interested in the census statistics. This committee, after careful and intensive study, made certain recommendations to the Bureau of the Census in regard to the forms of schedules to be used. All these recommendations were adopted.

In all, 167 special schedules, covering 243 industries, were used, whereas at the 1927 census there were 152 such schedules, covering 226 industries. The general schedule, which was used in canvassing 88 of the less important industries, carried 12 inquiries, 11 of which were identical, or nearly so, with the corresponding inquiries on the special schedules.

It had been the practice at former censuses to call for data on production rather than on sales, but the advisory committee recommended that the schedules for 1929 should call for data on sales and not on production, inasmuch as many manufacturers are able to report sales more readily than production. This recommendation was adopted with reference to the general schedule and most of the special schedules; but the provision for production data was retained in the schedules for a number of basic industries, especially those in which it was feared that the proposed change might seriously affect the comparableness of the statistics with those for previous years.

In order to obtain the information needed for the purposes of the census of distribution, an inquiry calling for data on sales through several different channels was added to the manufactures

schedules, and most of those schedules which did not already carry inquiries as to quantities and costs of specified materials consumed were expanded for the collection of data of this character. This elaboration of the schedules had the effect of delaying the canvass. Naturally, if a manufacturer receives a schedule which calls for a large amount of information of a detailed character, he is much less likely to fill it out and return it promptly to the bureau than he is to send in promptly the data called for by a relatively simple schedule.

The receipt of the returns was delayed also by the necessity of employing the same force of canvassers on the manufactures, the mines and quarries, and the distribution censuses. The number of establishments covered by the census of distribution (over 2,000,000) was ten times as large as the number of manufacturing establishments (slightly more than 200,000).

As a result of the delays arising from these two causes, only 155,989, or 74 per cent, of the net total of 210,000 returns had been received by June 30, 1930. In the motor-vehicle industry the outstanding returns represented 75 per cent of the total value of products.

Furthermore, the work of preparing the returns for tabulation was materially increased by the two special inquiries referred to above, which were added to the manufactures schedules for the purposes of the census of distribution. In a great many cases these inquiries were not answered, or were incorrectly or incompletely answered, even by manufacturers who supplied in full and in satisfactory form the remainder of the information called for; and this necessitated a large amount of correspondence which otherwise would not have been required. It has been roughly estimated that the correspondence in regard to these two inquiries represents at least one-third of the total correspondence in connection with the correction and completion of the manufactures returns.

In recent biennial censuses of manufactures the schedules have been distributed by mail, and following the usual practice blank schedules were mailed soon after January 1 to 191,866 establishments which had reported at the census for 1927 and to approximately 90,000 others whose names had been obtained from various sources.

CENSUS OF MINES AND QUARRIES

The census of mines and quarries for 1929 is one of the decennial censuses of the mineral industries, the first of which was taken in 1840. In the main, data for number of establishments, time in operation, wage earners, wages, cost of supplies and materials, value of products, power equipment, and fuels consumed have been collected at each census beginning with that taken in 1880. Data for capital, land holdings, rents, royalties, and taxes, as well as a detailed breakdown by kinds of employees, were omitted at the present census, and inquiries as to distribution of sales, equipment purchased, and mobile power equipment have been added to the

schedule. The sand and gravel industry was canvassed, for the first time, in connection with the census of mines and quarries.

The canvass has been conducted under the same plan as that adopted for the census of manufactures. The mailing list was the same as that used by the Bureau of Mines in its annual canvass covering mineral production. Schedules were mailed to establishments operating 28,044 plants. On June 30, 14,943 returns had been received, of which 7,920 were acceptable. Since that time a check with the returns of the Bureau of Mines has accounted for many plants as idle, abandoned, or too small to be covered by the census of mines and quarries.

CENSUS OF DISTRIBUTION

The reasons for the inclusion of distribution in the census were given in my report for the fiscal year 1929.

The law authorizing the census of distribution was enacted only a few days before the beginning of the fiscal year 1930. Consequently, during that fiscal year a very large part of the groundwork for this new phase of the decennial census was prepared in addition to the actual inauguration and conduct of the first stages of the work. An experimental census of distribution covering the operations of retailers and wholesalers had previously been taken in 11 cities in 1918; and a census covering purchases of manufacturers had been taken in Cuyahoga County, Ohio. These pieces of work, in addition to their immediate value, afforded some basis of experience upon which to proceed in planning the national census. A material and worthwhile amount of work had also been done relative to the schedules to be used, notably the retail schedules. An outstanding feature of this preliminary work was the adoption of a simplified schedule for small concerns and the use of a longer and more complex schedule, showing commodity sales, for larger establishments which were able to furnish such information and which conducted a large share of the nation's merchandising.

In order to determine the data that should be collected and the most constructive method of presenting the statistics, conferences were continued with representatives (associations and individuals) of the various branches of distribution. Early in the year a general advisory committee, with its executive committee, was established to give advice concerning the conduct of this work. With the advice of this committee, which broadly represented the leading authorities in the field, and others intimately versed in the problems, 10 schedules were prepared for use in taking this census. Thus there were established distinctive and separate questionnaires for the retail trade, the wholesale trade, and the purchase of commodities by construction companies. In addition, it was finally determined to include the operations of hotels and restaurants in the census of distribution. Furthermore, to make this census comprehensive, information regarding the sales made by manufacturers was needed. To meet this need special questions calling for information from manufacturers relative to their sales differentiated among different types of sales outlets were included in the schedules for the census of manufactures.

Following are brief descriptions of the forms of the 10 schedules which have been used in collecting the data on distribution:

Title	Use
COMBINATION SCHEDULE	
Combined retail and wholesale schedule (short form).	To be used to canvass all stores and other distributing agencies in rural districts and cities and towns having fewer than 10,000 inhabitants.
RETAIL SCHEDULES	
Retail schedule (short form)	To be used for all retail outlets, in cities having 10,000 inhabitants or more, which are unable to give sales by commodities.
General retail schedule	Long-form schedule to be used for retail establishments (except food and drug stores, and automobile and accessory establishments) in cities having 10,000 inhabitants or more, which can furnish detailed data regarding sales by commodities.
Grocery, delicatessen, confectionery, and and other food stores.	Long-form schedule to be used for all retail food outlets, in cities having 10,000 inhabitants or more.
Drug stores	Long-form schedule to be used for all retail drug stores, in cities having 10,000 inhabitants or more.
WHOLESALE SCHEDULES	
General wholesale schedule.	To be used for all wholesale establishments (except wholesale food stores) in cities having 10,000 inhabitants or more.
Wholesale food products.	To be used for all wholesale distributors of food products in cities having 10,000 inhabitants or more.
SPECIAL SCHEDULES	
Automobile schedule	To be used to canvass retail and wholesale distributors of new and used automobiles. Also to be used for the following establishments: Gasoline filling stations; retail distributors of tires and tubes, batteries, and automobile parts and accessories; automobile service and repair shops and shops which repair automobile tops, bodies, batteries, tires, and automobile accessories. Not to be used for storage garages which have no sales and which do not conduct a service or repair business.
Hotels	To be used for all hotels having more than 25 guest rooms. Hotels with fewer than 25 guest rooms are not to be canvassed. Hotels are to be canvassed by mail and are not to be visited by enumerators unless they receive special instructions from the supervisor.
Construction industry	To be used for all general and subcontractors engaged in the construction of buildings, bridges, roads, railroads, etc., who did work of this character to the value of $25,000 in 1929.

To carry on the work of the census of distribution successfully, six men who were familiar with the several branches of distribution were appointed as experts, each in charge of a particular branch of this work.

The field work in connection with the census of distribution has been conducted by the field division of the Census Bureau. It was estimated that returns would be secured from somewhat over 2,000,000 concerns. The majority of these are, of course, comparatively small establishments. At the end of the fiscal year returns had been received from 1,500,000 retail and wholesale establishments and country buyers, 100,000 construction contractors, and 17,000 hotels.

As these returns have been received they have been examined to insure consistency in the answers to the various questions, and considerable correspondence has been necessary in order to complete the reports from some of the more important concerns. The tabulation work is now organized. It is expected that the publication of reports

from the first run of cards will be started in August. The information presented in this preliminary publication will cover the total net sales of the establishments, the inventories, employees, and salaries and wages, classified according to kind of business, by States, counties, and cities.

VITAL STATISTICS

At the end of the fiscal year the Federal registration area for deaths covered 46 States, the District of Columbia, 1 city in South Dakota, 8 in Texas, and Hawaii and the Virgin Islands. South Dakota was not included in the registration area because it has not adopted a registration law that conforms with the requirements of the Census Bureau, and while Texas has such a law, the completeness of its enforcement has not yet been determined. In all probability a test will be made during the coming fall, and it is hoped that the State will enter the registration area before the close of the calendar year. For the same reasons South Dakota and Texas were not included in the registration area for births, which at the end of the fiscal year included 46 States, the District of Columbia, and Hawaii.

The work of securing copies of certificates from State registration offices has proceeded satisfactorily throughout the entire area, and by June 30, 1,386,219 copies of certificates of deaths, and 2,169,057 copies of certificates of births had been received for the calendar year 1929.

For 1928, 1,378,675 transcripts of certificates of death were received, and the death rate established at 12.0 per 1,000 population. This rate was slightly higher than the rate for 1927, the increase being due largely to the increase in deaths from influenze, the pneumonias, and diseases of the heart.

The tabulation of 2,220,187 birth transcripts for 1928 was also completed, showing a rate of 19.7 per 1,000 population—the lowest rate recorded since 1915, when it was 25.1 for the registration area, which was established in that year.

On the invitation of the Government of France, a conference was held in Paris during October, 1929, to revise the International List of Causes of Death. This conference was attended by representatives from 32 nations, and there were also present 7 representatives of international organizations. The United States was represented by Dr. T. F. Murphy, of this bureau, and 5 other delegates. Preceding the conference, the health section of the League of Nations had done considerable work tending to the perfection of the List of Causes of Death that would be used in compiling vital statistics for the different governments. The revised list, as established at the conference, will be used as a standard guide for the next 10 years for all the countries represented at the conference.

In addition to attending the International Conference at Paris, the chief statistician for vital statistics attended a number of conferences at which the method of collecting and compiling vital statistics was discussed. The biennial convention in Milwaukee of the American Nurses' Association, the National League of Nursing Education, and the National Organization for Public Health Nursing, Inc., was one of the most important of these conferences. The bureau has also been cooperating with the National Conference on

Street and Highway Safety and the White House Conference on Child Health and Protection, the Association of State and Territorial Health Officers, and the New England Health Institute. These conferences have all tended to establish greater accuracy in the collection and compilation of statistics and greater uniformity in their presentation.

The establishment of new birth and death rates, of course, awaits the establishment of final population figures of the census of 1930.

The change in the form of the standard certificate of death makes it necessary to publish and distribute another edition of the Physicians' Pocket Reference, which is generally used throughout the United States by physicians and others responsible for the preparation of the death certificates required by the laws of the several States.

Since the new standard certificate of death contains new inquiries relative to occupation corresponding to those on the population schedule, it was deemed advisable to prepare a Pocket Reference of Information on Occupations, similar in size and purpose to the Physicians' Pocket Reference.

The bureau has prepared a number of official and semiofficial tables concerning births and deaths, and has furnished a great deal of information on these subjects to foreign nations and to associations and others in the United States. Vital statistics compiled by the bureau are being used more generally, and the demand for special and detailed data on certain features is increasing monthly. To advance the publication of the most important features of the work, the bureau issued multigraphed statements covering births, deaths, infant mortality, and automobile fatalities. The Weekly Health Index, which is issued each Wednesday, gives the number of deaths in each of the large cities for which telegraphic reports have been received, and the 4-week summary of automobile fatalities, based upon telegraphic reports, which shows the number of fatalities from 78 of the largest cities, with a total population of about 33,000,000.

MARRIAGE AND DIVORCE

The statistics of marriage and divorce continue to be received by the public with a high degree of interest. The preliminary summaries, which are issued for the individual States in advance of the annual report and as rapidly as the data are received from the county officers, are given close study. This is especially true of localities where rigid State laws have been enacted in an effort to curb hasty marriages, or to make the granting of a divorce more difficult. The reports for the surrounding States are carefully scanned by the press of the country with a view of ascertaining whether the border counties show marked changes in figures, and the results observed are commented on at length.

It is unfortunate that lack of uniformity in the information recorded by the officials issuing marriage licenses in the various States prevents the publishing of anything further than the actual number of marriages performed in the United States each year, by States and counties, as many requests for additional data are received—

particularly data relative to the number of marriages performed each month and the age of the contracting parties. This latter item is of utmost importance in the study of child mortality statistics. Fairly uniform information on a number of items relative to divorces granted and marriages annulled is obtained from court records.

The statistics of marriages are now obtained from some office of the State government in 29 States, and the statistics of divorces are likewise obtained from State officials in 16 States. In the other States county officials furnish the information.

On June 30, 1930, the work of securing the information with regard to marriages and divorces in 1929 was about 96 per cent complete, reports having been received for 1,161,261 marriages, 197,741 divorces, and 4,346 annulments, as compared with a total of 1,182,497 marriages, 195,939 divorces, and 4,237 annulments, for the year 1928. Preliminary press statements have been issued for 35 States.

ANNUAL CENSUS OF INSTITUTIONS

The annual census of institutions covering State prisons and reformatories, State hospitals for mental diseases, and State institutions for feeble-minded and epileptics, has been continued by the collection of data for 1927, 1928, and 1929 from the heads of most of the institutions concerned, and from State administrative agencies, which have for the most part given commendable cooperation.

The tabulation of data pertaining to feeble-minded and epileptics for 1926 and 1927 has been finished.

The collection of data for the 1928 report for hospitals for mental diseases is finished and tabulation is under way. There still remain a few missing reports for 1928 both for the prisons and for the institutions for feeble-minded and epileptics. The blanks for the 1929 reports were sent out the first of May.

FINANCIAL STATISTICS OF STATE AND CITY GOVERNMENTS

The decennial census work has not interrupted the annual collection of the financial statistics of State and city governments, although in the last decennial census the compilation of these statistics was suspended during the year in which the census was taken (1920) and only partial reports were published for the following year. The publication of the reports covering the year 1928 has, however, been somewhat delayed by the necessity of waiting for revised estimates of population required as a basis for showing per capita figures. These estimates could not be made until the results of the population census were available. At the close of the fiscal year the work of compiling the statistics of 1929 was about 35 per cent compiled for the States and 40 per cent for the cities.

In previous annual reports reference has been made to the plan of having the census schedules filled out by local officials, thus relieving the bureau from the necessity of detailing experts from the Washington office to do that work. This plan which, when first adopted in 1925, covered only 1 State and 17 cities is now in operation in 40 States and 170 cities.

ELECTRICAL INDUSTRIES

This census has been taken at 5-year intervals since 1902. The canvass covering activities in 1927 was made in 1928, and the work of compiling the statistics and preparing them for publication had been brought to practical completion by the close of 1929. The reports on telegraphs and telephones were sent to the printer in September of that year, but, because of the pressure of the Fifteenth Decennial Census work, the completion of the text for the electric light and power and the electric-railway reports was delayed until about the close of the fiscal year 1930.

SURVEY OF CURRENT BUSINESS

The Survey of Current Business, consisting of monthly and weekly statistical reports on the trend of various kinds of business, was issued regularly by this bureau until June 12, 1930, at which date it was transferred to the Bureau of Foreign and Domestic Commerce in order to consolidate it with the work and preparation of the Commerce Yearbook in that bureau. The Survey of Current Business brings together the current reports of business activities issued by this bureau, as well as those compiled by other Governmental agencies and by representative private organizations, including trade associations. At the time of transfer it contained 1,800 individual statistical series, covering approximately 480 commodities.

QUARTERLY, MONTHLY, AND SEMIMONTHLY INQUIRIES

The list of these inquiries, whose results are published in 69 series of reports, is too long to justify presentation here. The extensive compilations of statistics on cotton and cottonseed, wool, leather, and wheat and flour, described in previous annual reports have been carried on as usual.

An increasing number of monthly reports based upon primary data collected direct from business and industrial establishments have been compiled and published. These reports have been mimeographed as specific units of information and released directly in this form to the press and to those establishments which supply the data. As a rule, they are published monthly and show production, sales, stocks, and unfilled orders. The demand for this type of current reports is increasing rapidly. During the fiscal year eight new inquiries were inaugurated, and several others have been undertaken since the close of the year, or are likely to be undertaken in the near future. The eight new inquiries are as follows:

(*1*) *Automobile financing* (*monthly*).—This inquiry, which covers number of cars and volume of business in dollars handled by automobile-financing organizations, was undertaken at the request of the National Association of Finance Companies. The number of reporting companies increased during the year from 338 to 455, and the scope of the inquiry was enlarged to cover wholesale financing of dealers' stock as well as retail financing. This inquiry affords almost the only authentic information in regard to installment sales of automobiles, and supplements the motor-vehicle production figures, which have been published monthly for nearly 10 years.

(*2*) *Oil burners* (*monthly*).—The oil-burner canvass, undertaken at the request of the leading manufacturers, originally covered 50 companies. A considerable number of additional manufacturers have begun to report.

(3) *Paint, varnish, and lacquer (monthly).*—This inquiry, which had been carried on semiannually until June, 1928, was suspended until the beginning of the fiscal year 1930 and was then resumed on a monthly basis. The inquiry has been simplified so that it now covers total sales only.

(4) *Plastic paints, cold-water paints, and calcimines (monthly).*—The manufacturers of these classes of paints, who had formerly been canvassed semiannually together with manufacturers of other paints, varnishes, etc., requested the compilation of separate statistics of their sales by quantity and volume. The first compilation was completed within the fiscal year 1930, but the report was not issued until July

(5) *Plumbers' woodwork (monthly).*—This inquiry, undertaken at the request of the Plumbers' Woodwork Institute, covers 17 manufacturers whose output constitutes at least 80 per cent of the total for the industry. The initial report, which was compiled before the close of the fiscal year and was issued in July, 1930, supplements the other current sanitary-ware reports, namely, those on enameled-iron sanitary ware, vitreous-china plumbing fixtures, and porcelain plumbing fixtures.

(6) *Prepared roofing (monthly).*—Incomplete statistics on the production of prepared roofing has been published in the Survey of Current Business for some time. Within the fiscal year these were supplanted by substantially accurate and complete statistics covering each month of the period from January, 1928, compiled from data supplied by 36 manufacturers whose output constitutes practically the total production of prepared roofing. Members of the Asphalt Shingle and Roofing Association report through the association, and nonmembers send their reports directly to the bureau.

(7) *Pulverized-fuel equipment (monthly).*—This inquiry, which was needed in order to enable the bureau to compile statistics supplementing those on steel boilers and mechanical stokers, which had been published monthly for some time past, was begun at the request of the Pulverized Fuel Equipment Association. It covers, as far as is known, every manufacturer of this type of equipment.

(8) *Range boilers (monthly).*—Thirteen manufacturers, whose output represents practically 80 per cent of the total production, now cooperate in this inquiry, which was undertaken at the request of leading producers.

CARD PUNCHING AND TABULATING MACHINES

The increase in the subjects covered by the census and the increase in the detail now included over that heretofore covered, as well as the great diversity of data required by additional subjects, made it necessary to reorganize the tabulating force of the entire bureau. This force is now concentrated in two divisions. One is responsible for punching all of the cards and the other for tabulating the cards on the electric machines.

The tests of punching machines made in 1929, developed the fact that the mechanical key punch machine was far superior to the pantagraph machine used in the preceding censuses for the punching of the individual cards and that the electric duplicating key punch would increase the production of the cards punched from the general farm schedules materially. The duplicating key punch will also be used for punching cards from the censuses of distribution and manufactures. The mechanical key punch will be used for punching the cards for the census of the unemployed and also the cards that will carry the statistics for the tabulation of families.

Due to the use of these punches and the improved mechanical equipment installed to assist the operatives in their work an increased production per clerk is expected of more than 100 per cent over that in preceding censuses. That this anticipated increase in the average number of cards punched will be realized is seemingly justified by the record to date. The average number of cards punched per day per clerk to June 30 for the 1930 census is 1,078, as compared with 512

cards on the same relative date in the 1920 census. When all operatives have become experienced, and the work is at the peak, it is expected that the average number of individual cards punched per day per clerk will be approximately 2,000 as compared with 864 in 1920.

The total individual cards punched and available for tabulation at the close of the fiscal year was 1,845,575, as compared with 95,662 on the same relative date in 1920.

In the past few years a new sorting machine has been developed by the mechanical laboratory which, apart from basic principles, is quite different from any sorting machine ever used by the bureau. Chief among the improvements is the methods of conveying the cards to the various boxes. This is done by a series of small rollers that carry the cards along and deposit them in appropriate boxes at the rate of about 400 per minute. Other improvements over the old-type machine are greater card capacity in card bins; elevators in card boxes to keep cards in place; an automatic stopping device to prevent cards from tearing in case of a jam; and a check counter that registers the total number of cards sorted. The new machine is also equipped with a full-width sorting block by means of which any column on the card may be sorted by merely moving the brush.

A number of improvements have been made in the mechanical and electrical features of the tabulating machines, the principal improvements being the placing of an additional starting switch on the front of the machine so that it may be started or stopped from either side, and the changing of the construction of the counters to permit greater accuracy and longer life.

The various kinds of work in the tabulation division will require the use of a minimum of 166 sorting and tabulating machines. This will constitute the largest plant of its kind in the United States, in fact, in the world.

INDUSTRIAL AND BUSINESS STATISTICS

Until the beginning of the present century the only comprehensive industrial satistics which had been compiled by any agency, Federal or other, were the decennial census statistics on manufactures and mines and quarries. When the Census Office was established on a permanent basis in 1902 it was charged with the duty of taking quinquennial censuses of manufacturing industries and of electric light and power plants, electric railways, telephones, and telegraphs, and of collecting and publishing, at frequent intervals during each crop season, statistics showing the amounts of cotton ginned to specified dates. Since 1905 monthly reports on the supply, distribution, imports, and exports of cotton have been prepared and published; the compilation of monthly statistics on cottonseed and cottonseed products was begun in 1916; and from time to time other inquiries made at intervals ranging in length from a week to a year were inaugurated. Beginning with 1921, the census of manufactures was placed on a biennial basis; the census of agriculture has been taken quinquennially since 1920; and the first comprehensive census of distribution was taken as a part of the decennial census of 1930.

Thus, during the 28 years that have elapsed since the Census Bureau came into existence as a permanent organization, the scope

of its inquiries covering industry and commerce has been greatly extended. Moreover, most of these inquiries are now made at much more frequent intervals than formerly, and a number of them—those made at annual or shorter intervals—are what may be called "continuous," in that each canvass covers the entire period which has elapsed since the close of that covered by the preceding one. (Each canvass made at intervals of two years or more covers industrial or other activities during only a single year.)

As a result of these numerous censuses or surveys, a great mass of statistical information is made available for the use of industrial and business men generally. Much of this information has a permanent value; but its immediate value—its value as a guide in planning sales campaigns, in deciding whether to increase or decrease production, etc.—depends upon promptness of publication and dissipates rapidly with the passage of time. In order that the industrial and business statistics may be of maximum value for this purpose, preliminary summaries should be published within a few weeks after the close of the periods to which they relate. This is done in the case of the cotton-ginning statistics, which are published eight days after the close of the periods covered; and the corresponding lapse of time for some of the monthly summaries is only a week or two. In other cases, however, the delay in publication is greater, and the amount of this delay increases with the amount of detailed information presented in the reports. As a rule the Bureau of the Census is able to publish a preliminary report covering a certain inquiry or branch of an inquiry—for example, one of the 331 manufacturing industries—within a very short time after complete and correct returns have been received from all persons or establishments canvassed. In fact, practically all the delay in the publication of preliminary census reports may be accounted for as the result of two causes, and only two: (1) The failure of the persons canvassed to supply promptly the information called for, and (2) their indifference and carelessness in answering the inquiries on the schedules, which render it necessary for the bureau to obtain by correspondence the additional data needed. It is no exaggeration to say that if all the bureau's schedules were returned promptly, and if all inquiries were answered completely and correctly the publication of the census statistics would be advanced many months—in some cases more than six months.

It may be pointed out here that the censuses of industry and business fall into two general classes: (1) Those which are comprehensive and detailed, covering the entire field with as close an approach to thoroughness and completeness as possible; (2) those which cover some one item or a few related items regarding production, sales, stocks, etc. These two classes of inquiries differ sharply from each other and serve different purposes. The former have a permanent value, and promptness of publication, although desirable, is not absolutely essential. The value of the latter, on the other hand, lies mainly in promptness of publication; and if the reports do not become available in time to enable industry and business to use them as guides in planning their activities in the immediate future, they fall short of serving their purposes. The distinction between these two classes of inquiries should be kept clearly in mind by those who are

interested in the census statistics. It is possible to collect and compile comprehensive statistics; it is also possible to collect and compile statistics and publish them promptly; but it is not possible to combine these two features—comprehensiveness and promptness of publication—in the same census.

It can not be too strongly emphasized that if business and industry want statistics published promptly enough to be of real current value, business and industry must cooperate with the Bureau of the Census in doing two things: First, simplifying the questionnaires so that the data called for can be supplied readily and easily; second, filling out these questionnaries and mailing them to the bureau promptly instead of waiting until after several "reminders" have been sent.

Very truly yours,

W. M. STEUART,
Director of the Census.

BUREAU OF FOREIGN AND DOMESTIC COMMERCE

DEPARTMENT OF COMMERCE,
BUREAU OF FOREIGN AND DOMESTIC COMMERCE,
Washington, July 1, 1930.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: Our country, like most of the countries of the world, has just closed a difficult trade year. There has been no fault in the merchandise nor lack of skill in salesmanship. Complicated economic conditions, world-wide in scope, represent the fundamental factors back of the recession.

In this situation the Bureau of Foreign and Domestic Commerce, believing the Government could aid materially in the stabilization of business by contributing statistics and sound information on world trade movements and events and by providing factual bases on which domestic merchandising could build for the future, expedited the gathering and distribution of facts and figures, increasing its cable service on conditions abroad by 25 per cent and strengthening all of its statistical and informational services; and on behalf of domestic commerce it rushed to completion those researches which could be hurried.

Immediate response from the business public was seen. Requests upon the bureau were a thousand a day more than in the preceding year; for the fortnight ended June 28 they numbered 78,000, for the full year 3,632,000, a record total; and evidence of the practical value of the assistance offered came when firms which had sought the bureau's aid (but only 7 per cent of the number regularly served) reported more than $50,000,000 in new business and savings thus made possible.

DOMESTIC BUSINESS SITUATION

Although the decline in our domestic industry and commerce was ushered in by the stock-market crash of October, 1929, that event itself was preceded by a significant and world-wide falling off in the price of nearly every important raw material. This decline in raw-material prices is still in progress, but there is reason to believe at the writing of this report that the bottom is being reached. So long as raw materials continue to drop, industry will continue to purchase for current consumption only, hoping for still lower prices. This, of course, results in reduced activity and unemployment. There is abundant evidence that the inventories in most industries of both raw and finished products are at a very low level. As soon as some confidence is established that raw-material prices have reached bottom, we may expect to see these industries purchasing to bring their inventories up to normal, and manufacturing activity will likewise increase, with resulting relief to unemployment.

Throughout this period of decreased activity consumer buying in most lines seems to have been well maintained. The sales by department stores declined less than 5 per cent in dollar value for the first six months of 1930 compared with January–June of 1929. If account be taken of the lower price levels of this year, it is reasonable to assume that the quantity of goods moving into consumption through these outlets was but little less than in the preceding year. Food sales have apparently been somewhat larger in volume than a year ago. Sales of such commodities as jewelry and furniture have been decidedly smaller.

THE DECLINE IN FOREIGN TRADE

Our foreign trade during the past fiscal year showed an appreciable decline in contrast with the usual increases of recent years. The fundamental cause was the world-wide business recession. Other countries likewise have seen their exports and their imports fall off.

Exports of domestic products in the year ending June 30, 1930, were some 13 per cent below those of 1928–29, or $4,618,000,000 against $5,284,000,000; imports were 10 per cent less, $3,849,000,000 as compared with $4,292,000,000. Losses appear in all classes of exports and imports and in the trade with all the geographic divisions of the world, as shown by the table below.

Commodity classification	Decrease [1]		Geographic classification	Decrease [1]	
	Exports	Imports		Exports	Imports
	Per cent	*Per cent*		*Per cent*	*Per cent*
Crude materials	16.8	13.3	Europe	9.3	8.8
Crude foodstuffs	32.8	12.0	North America	12.4	11.5
Manufactured foodstuffs	8.6	16.2	South America	20.8	9.0
Semimanufactures	12.8	7.6	Asia	17.4	10.3
Finished manufactures	8.6	4.5	Oceania	16.8	29.8
			Africa	9.9	15.6
Total	12.6	10.3	Total	12.6	10.3

[1] Decrease (dollar basis) in fiscal year 1929-30 when compared with total for 1928-29.

While a considerable part of the decline in the case of exports, and still more in the case of imports, was due to lower prices, there were actual decreases in the quantities of many leading commodities.

UNITED STATES LOSS PART OF WORLD RECESSION

The results of diminished exports are sometimes plain to see, especially in industries which export a large proportion of their output, in unemployment and passed dividends; the underlying causes often are obscure to the casual observer. The factors which have brought about the decline in our trade are largely of a world-wide character and represent only in part conditions and events in the United States.

For some years past prices for the foodstuffs and raw materials which constitute the major source of buying power of many countries have been tending downward, thus lowering their ability to buy imported commodities. Of certain of these commodities there has been overproduction, and excessive stocks have accumulated. The

speculation in American securities, which culminated in October, 1929, is commonly believed to have exerted also a disturbing influence on foreign buying power for American products. The sharp rise in rates in the New York money market curtailed the flotation of foreign loans in this country and at the same time attracted here a very large volume of foreign short-term funds, and these conditions lessened the ability of many countries to finance their industries and commerce and in some cases made the maintenance of the exchange value of their currency difficult or impossible. In a number of individual foreign markets special factors have exercised a serious influence—for example, the collapse of the Brazilian coffee valorization scheme, with the consequent great fall in the price of coffee, which constitutes the major export not only of Brazil but of several other Latin American countries.

It seems probable that the bottom in raw-material prices will soon be reached, and when an upturn comes we may expect to find the buying power of foreign countries increased. Meantime the subsidence of the American stock market has not only relieved the stringency in credit for industry and commerce in this and other countries, but has brought about great activity in foreign-loan flotations in the United States. The resultant ease in money rates has already afforded much relief in the economic depression and will no doubt serve to shorten its duration.

The following summary of economic conditions in the foreign markets where we buy and sell will enable one better to gauge the significance of the year's declines in our exports and imports:

EUROPE

In Europe the calendar year 1929, considered as a whole, was the most favorable since the war, just as was the case in the United States. Industrial activity was greater in nearly every country than the year before. Unemployment was less prominent than in 1928, though the average for the year was rather heavy in Germany, the United Kingdom, and a few other countries. A scarcity of laborers had even developed in one or two countries (especially in France). Good crops, particularly of cereals, proved of advantage to the farmers, despite somewhat reduced prices, while the consequent smaller requirements for imported grain promised improvement in the trade balances of Europe with the rest of the world. Government finance in most countries was strengthened, with tax reductions in France and Belgium. The outstanding adverse factors were the general weakness of the textile industries (except rayon), the tendency toward price declines, the weakness of the domestic market, notably in Germany and the United Kingdom, and in certain countries high interest rates resulting from the American stock speculation, and a moderate repercussion after the break in stock prices in the autumn.

Recent months in Europe, as in the United States, have witnessed a recession in foreign trade and in domestic industry and commerce. The recession varies in degree, being less severe in France and Scandinavia, and most severe in Germany and Great Britain.

In the Scandinavian and Baltic countries, Denmark in particular, low prices for certain export products were the only adverse factor of importance during the first half of 1930, and these were largely counterbalanced by corresponding decreases in prices of essential imports. Industries in the Netherlands and Belgium were fairly well sustained early in 1930 by the strength of the domestic market derived from earlier prosperity; but the former was affected by the poor agricultural situation and the slump in prices of colonial raw materials (rubber and tin) which narrowed its export markets, and the latter by the gradual decline in export demand with its reflection on domestic prosperity. France continued to benefit from strong domestic demand and the 1929 reductions in tax rates; indices of general business were equally as good in the first half of 1930 as in the corresponding months of 1929, but failed

to show a continuation of the previous improvement. Exports shrank in the first half of 1930, but as imports declined in greater degree the net result was not notably depressive.

Great Britain has been, perhaps, the chief sufferer, because of its dependence on foreign trade; curtailment of its Latin American and far eastern markets, largely as a result of low prices for the primary products of these regions, has figured prominently in the increasing industrial slackness. The main difficulties in Germany have been internal. Italy has suffered to some extent from reduced export demand and from low prices for exportable agricultural products but has profited from last year's good cereal crops in the way of lower import requirements, and the general situation is not appreciably worse than a year ago.

CANADA

Developments in Canada have been greatly influenced by those in the United States and have followed them more or less closely. Progress in mining, even in the face of lower mineral prices, has served to offset somewhat the agricultural depression. In the Maritime Provinces general business compares favorably even with last year's levels; Ontario and the Prairie Provinces—the former because of the concentration of industry there, the latter on account of the wheat situation—seem to have felt the depression more keenly than other sections.

LATIN AMERICA

Throughout the entire Latin American area, from Mexico to Tierra del Fuego, not a single region escaped the effect of the depression. In general, it may be said that the falling off in the world demand for the major export products of Latin America and the constantly increasing production of these commodities there and, in some cases, in other parts of the world were the decisive elements in the situation.

In Mexico, political and social factors aggravated the unfavorable economic conditions, as did also falling prices for silver and other metals. In Central America the decline in coffee prices was the major adverse factor. In Cuba, which is nearly 90 per cent dependent on sugar and sugar by-products as a source of revenue in foreign trade, prices lower than they have ever before been in history, owing to world overproduction of beet and cane sugar, brought about a major depression. In the other islands of the West Indies low prices for sugar, coffee, cacao, and other articles of commerce were the leading unfavorable factors.

In Colombia, fiscal difficulties added to the difficulties caused by low coffee prices. In Venezuela, Ecuador, and Peru, declining prices for all the major agricultural and pastoral products, including coffee, cacao, hides and skins, and cotton, exercised an adverse effect upon the situation, which in Peru was aggravated by declining copper prices. Bolivia's difficulties arising from a drastic drop in tin prices were increased by fiscal difficulties. In Chile competition from synthetic nitrogen fertilizers, declining nitrate prices (with a corresponding loss in revenues), the fall in copper quotations, and softness in the markets for agricultural products were the major elements in the current depression. Argentina suffered from poor crops and declining prices for cereals and wool. The slackening of demand for Argentine beef in the British market caused by the depression in England is bringing about a decided weakness in meat and meat products. Uruguay was adversely affected by the same factors operating in Argentina, the drop in wool prices being particularly important. Paraguay suffered chiefly from the depression in Argentina and in other neighboring markets for its goods. Brazilian depression is attributable chiefly to the collapse of the coffee valorization program, to financial difficulties, and to the decline of the milreis.

FAR EAST

At the beginning of the fiscal year China seemed marked for improvement in economic as well as political conditions. However, military activities in Manchuria later brought trade almost to a standstill, and in the last half of the year military activities on a wider front throughout Central China, the most productive region, resulted in the most serious dislocation of trade since

1925. Moreover, the heavy reduction in the price of silver greatly depressed China's import trade, while disrupted lines of communication and heavy tax exactions throughout the interior curtailed export trade. China's trade and economic situation has rarely been more uncertain than in recent months. The only present redeeming feature is that throughout the Yangtze Valley and China generally the new crops of wheat and rice are reported as of unusual volume and at least average quality.

The retrenchment policy of the Japanese Government, together with financial and industrial readjustments preparatory to lifting the gold embargo, retarded business and deepened industrial depression in Japan during the last half of 1929; and following the removal of the gold embargo on January 11, 1930, conditions became more depressed as a result of the world-wide recession in commodity prices and slackened demand in domestic and foreign markets. Industrial production was greatly curtailed and unemployment increased. Import trade during the first half of 1930 was affected by the retrenchment policy, while the decline in silver, as well as the increased Indian tariff on cotton textiles, retarded exports to China and India. Some improvement is expected in export trade during the last half of 1930, but the general outlook for business and industry is not favorable.

Overproduction and low prices for leading export products rendered Philippine business uncertain in the second half of 1929, and with no improvement in world markets and with further price declines depression became general in the first half of 1930. The banks became increasingly cautious in giving credit extensions, and general purchasing power continued to shrink. The consequent reduction in demand for imported goods resulted in keen competition, and several important failures. Although merchandise stocks were considerably reduced by May, 1930, improvement was not sufficient to cause substantial increases of import orders.

The year was marked by uncertainty in Australia's progress. Wheat and wool prices reached very low levels, unemployment increased, overseas loan markets were unfavorable, and an exchange situation developed which placed a heavy penalty on the importer. In an effort to correct the situation an emergency tariff measure was adopted which drastically cut imports and gave promise of cutting down somewhat the large adverse trade balance. The outlook is not satisfactory; unemployment is still a major problem, commodity prices are still low, and the exchange situation has not improved to any great extent.

New Zealand began the year in high spirits, but as the months passed falling commodity prices caused business men to retrench. In sympathy with the Australian exchange situation, New Zealand exchange became difficult to obtain, and importers were paying the highest premium in years for drafts. The outlook, while not satisfactory, is better than for Australia.

At the beginning of the fiscal year Indian conditions appeared satisfactory, but by the end of 1929 prices for most of India's export products had begun to decline and internal disturbances throughout the country interfered with the normal trend of business. During the early months of 1930 prices continued to fall, disturbances became more widespread, and by June business in most lines was practically at a standstill. The outlook is not encouraging though crop propects are good.

Rubber prices in Ceylon declined during the fiscal period to a point where small profit was left for plantation owners and efforts were being made to adjust the cost of production to the new price levels. Banks were restricting credits and many bankruptcies were occurring throughout the island. The outlook depends upon commodity prices and the ability of rubber plantations to adjust production costs downward.

Unfavorable conditions in rubber and tin markets caused a general business depression in Malaysia about the middle of 1929, which continued unabated. Import trade showed the effects of curtailed retail buying. Heavy stocks accumulated, collections were slow, and dealer demands for credit extension made the financing of imports difficult. Attempts at restriction in output of rubber and tin were ineffective in the main, and exports of both commodities during the first half of 1930 were heavier than in the corresponding period of a year previous. In Java prolonged drought in 1929 reduced the output of many native crops and caused unusually heavy imports of staple foodstuffs. By the middle of 1930 the situation was somewhat relieved by a more favorable rice crop.

With this world picture in mind, the losses in our foreign trade take on their rightful relative proportions.

THE BUREAU'S DOMESTIC COMMERCE WORK

Several years of research in the field of domestic commerce came to fruition at a time when the need for the factual bases thus laid was intensified by the uncertain state of domestic trading. Completion of a dozen or more of these studies at this juncture was particularly fortunate. Outstanding among the reports appearing in 1929–30 were the Market Data Handbook of the United States, which, unsolicited, won the Harvard award in advertising research; two volumes of the Commercial Survey of New England, a research declared to be of great value in the future development of that section; and a volume of similar scope on the Commercial Survey of the Pacific Southwest.

The Market Data Handbook was released on December 4, 1929, and within three weeks the entire first sales edition of 3,000 copies was disposed of; a second printing of 3,000 copies was sold practically before it was off the press, and sales are being well sustained on the third printing. This Handbook, which has been enthusiastically commented upon by marketing and advertising authorities, was designed to meet the demand for statistical information upon which to base economical marketing and advertising operations. A unique feature is that not only were data from governmental sources included, but also statistics furnished by eight private organizations, and not hitherto published, were generously contributed to the making of what is probably the most comprehensive compilation of its kind.

The National Retail Credit Survey, giving the experience of more than 23,000 retail merchants in 27 different lines of trade and with annual sales in excess of five billion dollars, was another useful publication of the year.

Numerous other researches which have proved of unusual value to the groups sponsoring them also were brought to completion last year.

PRACTICAL APPLICATION OF DIVISION'S STUDIES

Publication of the results of the Louisville grocery survey of the preceding year has led to a broad movement for trade betterment. Material from that report has been republished by trade associations and leading trade magazines; local programs for improvement of store arrangement, store record keeping, and retail merchandising have sprung up in various sections of the country. At the present moment a member of the domestic commerce division is acting as adviser to a group in the food trade which is putting on a store-remodeling program at Jacksonville, Fla.

Several associations have passed resolutions commending the Department of Commerce for carrying on business analysis of this sort. The Louisville Board of Trade stated that the grocery survey had a minimum value of $100,000 to the city of Louisville alone; one private correspondent placed this value at half a million dollars. Favorable statements concerning it have come in from all sections of the United States, most European countries, and from other parts of the world.

Other evidences of appreciation of the bureau's services in behalf of domestic commerce are seen in the numerous requests for speeches before trade associations and other commercial groups; although seriously handicapped by lack of travel funds, more than 200 addresses were delivered the past year. The greatly increased amount of space devoted in trade journals and business papers to discussion of the domestic-commerce work, even to reprinting many of the bulletins in full, is still other evidence of the growing recognition of what the bureau is achieving.

COST-OF-DISTRIBUTION RESEARCHES

Extension of the bureau's work in the field of distribution-cost analysis to include the detailed study of a wholesale dry-goods house, a wholesale paint and varnish house, and an electrical-appliance establishment aroused keen interest. The study of wholesale dry-goods merchandising was completed in January of this year and the report thereon is expected to be released soon. The wholesaler whose business was used as the laboratory for the study was then distributing over 17 States but is now confining his sales efforts to 3, with resulting increases in net profits.

A preliminary report on the paint study was issued in February; the final report will appear during the current month. The paint wholesaler whose business was analyzed has reorganized his selling force and cut many superfluous commodity items from his stock. The president of the Paint Manufacturers' Association declared that this paint survey was worth at least a million dollars to the industry.

A preliminary report on the electrical study was made in May, and the manuscript of the final report is almost ready. The electrical wholesaler whose operations were studied has faced the fact that his sales policy was founded on sales volume, without rigorous selection of outlets. He has started on a new program that calls for the building up of stable and well-rounded outlets throughout his territory.

In all of these cases the example of the wholesaler studied has been very effective in getting other merchants to adopt more efficient methods of operation.

Decided benefits have been reported from various sections of the country as a result of studies based on the data obtained in the Louisville grocery survey. New studies have been published since the release of that report, namely, Census of Food Distribution, Selling Coffee Through Retail Stores, and Selling Cereals Through Retail Stores. A pamphlet dealing with retail-store arrangement, entitled, "The New View of the Retail Store," presented findings from the grocery and paint surveys. Another small bulletin, covering cost-allocation procedure followed in all studies to date, was prepared under the title, "Method of Cost Allocation in Distribution Accounting."

CREDIT EXTENSION AND BUSINESS FAILURES

It is believed that an important factor of our prosperity of recent years has been the use of credit in retail merchandising. A survey of retail credit practices, published in three reports, has just been made available to the public. A striking fact brought out by

this survey is the wide variation in practice existing among stores of the same kind. Numerous individual stores were found with credit loss percentages twenty-five times as great as those of other stores; some stores were found with percentages of returned merchandise ten times as great as those of other stores, and some with collection percentages half as large as others.

Another significant finding was the comparatively low collection percentages of many retail establishments. The regular charge-account collection precentages of department stores indicated that the average time accounts receivable were outstanding approximated 2¼ months. While this was the average, there were numerous individual stores with collection percentages indicating that their accounts receivable were outstanding for an average of 120 days. Reports from 3,355 retail establishments of all kinds indicated that the open-account collection figure for the whole country was 44.1 per cent, which means that the average length of time open accounts receivable were outstanding for all types of stores was 68 days. Reports from 597 establishments, including department stores, furniture stores, automobile dealers, electrical-appliance stores, and miscellaneous establishments show that the installment collection percentage for the whole country was 13.5 per cent, which means that this type of account was outstanding a little over seven months.

The study of credit extension and business failures made as a part of the Louisville Grocery Survey confirmed the importance of knowing where good business practice ends and sympathetic tolerance of unpaid accounts begins. To what extent should the retailer's account be nursed by the use of credit? When does it cease to be a constructive, business-building factor and become an agency of ultimate destruction? It is of vital importance to both parties to the credit transaction to know, for in failure both parties lose. One grocer studied failed owing more than 50 creditors, of whom the majority were wholesalers, jobbers, and manufacturers; another owed 40 creditors, among whom were wholesalers with unpaid bills amounting to $400 and $500 each. It was found that losses were principally the result of carrying accounts for merchandise under conditions and to an amount unwarranted by the facts, had the creditor known and considered them for guidance. Only 10 per cent of the original capital with which the grocers established their business was in the form of credit extension from the wholesalers from whom their stock was obtained. In the majority of the failures studied the business had been established with the owner's own capital.

A like investigation of credit extension and business failures has been made more recently in Philadelphia. This study showed that credit losses in Philadelphia were a comparatively small factor as a cause of failure among the retail grocers of that city, since credit is extended carefully and collections watched closely by the wholesalers. There is a great deal of cooperative wholesaling in Philadelphia; that is, the function of the wholesaler is performed by associations of retailers. These associations extend credit to their members on a weekly basis and penalize overdue accounts; the wholesaler requires the retailer to meet his bills promptly, and the retailer is thus forced to exercise care in extending credit to his customers.

COMMERCIAL SURVEY OF NEW ENGLAND

Last year a series of studies was completed regarding industrial and commercial operations in New England. For the convenience of the user these studies were published in separate volumes entitled "The Industrial Structure of New England," "The Commercial Structure of New England," and "The Market Data Handbook of New England." Not only has this work proved valuable in the direct application of the information to the shaping of marketing policies, but numerous instances have been reported of adapting the technique and method of these studies to other problems and to other localities.

The Industrial Structure of New England presents in Part I the natural characteristics and resources of the area and analyzes the basis of agricultural production; Part II gives an analysis of transportation, power, and fuel; and Part III the factors affecting industrial production in New England. The Commercial Structure of New England analyzes distribution within the 13 major distributing areas of New England, contains chapters on wholesaling, retailing, consumer buying habits, the food markets of that section, and commercializing recreational resources. The Market Data Handbook of New England (not to be confused with the handbook covering the entire United States) is a working manual that has been used extensively in laying out sales quotas, routing salesmen, and determining areas which can profitably be handled.

At the request of New England business organizations, a survey was undertaken by the bureau in October, 1929, designed to secure information on the nature and value of New England's foreign trade, its destination, methods of shipment, points of export, and other pertinent matters useful in developing a program of sound trade promotion in foreign markets. The report will be published early in the current fiscal year. It will provide small and large manufacturers alike with basic facts that will aid them in extending their foreign markets. This survey completes the special studies of New England which have been in progress the past three years.

OTHER REGIONAL SURVEYS

The Commercial Survey of the Pacific Southwest, the third in the series of regional studies, is in press. Numerous requests for it have already been received.

Two other regional surveys are in progress, one of the Pacific Northwest and one of the Gulf Southwest. Field work on the Pacific Northwest has been completed and the manuscript is in process of preparation. The material gathered in the Gulf Southwest survey will be presented in a number of bulletins as rapidly as possible: certain of the studies have been made and will soon be issued under the titles, "The Production and Distribution of Petroleum in the Gulf Southwest," "The Distribution of Hardware," and "The Distribution of Dry Goods." In the dry-goods survey 72 wholesalers and 376 retail outlets participated; in the hardware survey, 100 wholesale houses and 443 retail outlets. The two studies will be replete with information on the expense of operating, methods of sales promotion, problems of buying and selling, stock control, adver-

tising, elements of competition, and analyses of the market areas served.

These survey reports are finding a distinct place in the literature of the business world as guides to intelligent planning and sound commercial practice.

INDUSTRY SURVEYS

At the request of the International Association of Blue Print and Allied Industries a study was made of the problems affecting distribution in those industries and a report published giving the total volume of business and an analysis of operating costs and net income. The survey showed not only that small orders were unprofitable, but that the minimum size of order that could be handled with profit was much larger than members of the industry had previously estimated.

The Survey of Gray Iron Foundries was released in December, 1929. A somewhat similar study concerning machinery used in the knitted-outerwear industry was conducted in Philadelphia; the final report, prepared jointly with the industrial machinery division, was released in June, 1930.

PERIODIC PUBLICATIONS OF THE DIVISION

The 1930 edition of Market Research Agencies, a compilation of public and private agencies carrying on research bearing upon domestic marketing, indicates an increase in the number of agencies working in this field and a higher character of researches and greater scope of subject matter.

Another service of the domestic commerce division which has attracted unusually favorable comment has been the issuance of a multigraphed bulletin under the title, "Domestic Commerce." This periodical attempts to cover briefly the significant developments in marketing and distribution. It is prepared with the idea of getting before the busy executive the important activities in this field, with references which will enable him to follow up those in which he is particularly interested. Thousands of commendatory letters attest the success with which the bulletin is meeting.

OUTLET FOR BUSINESS RESEARCH

The various departments of the Government and nongovernmental organizations compile a vast amount of research material which can be applied to business and would more generally be put to practical use if the average business man knew where to find the particular material which bears on his specific problem.

Because of the widespread recognition of the obvious need for a central clearing house for results of authoritative business research, there functions within the domestic commerce division a special section to which domestic-trade inquiries are sent after first being routed to the appropriate commodity division, if a commodity is mentioned. This section endeavors to analyze, in relation to subject named, available information from all authoritative sources; to coordinate the results of business research which will apply to each question; and to put the inquirer in touch with experts in any depart-

ment of the Government whose work bears upon the problem submitted. The transfer of the Survey of Current Business from the Bureau of the Census to the Bureau of Foreign and Domestic Commerce will greatly facilitate these services.

Each year has seen a steady increase—last year, one of 20 per cent—in the demand for this type of assistance.

THE SMALL-BUSINESS SECTION

The small-business section, created to establish and maintain contact with such mercantile interests as were not already provided with channels of approach to bureau benefits, is meeting with increased demand for the service it has to offer. Its energies were directed last year largely to the cultivation of the Negro business factors of the country, since this group represents a people with a minimum of such contacts. However, its work is not confined to that group. The foreign-born merchants have been accorded attention which has been well received. The general American business units in the smaller brackets have been furnished some assistance with equally gratifying results.

DOLLARS-AND-CENTS RETURNS IN FOREIGN-TRADE PROMOTION

Although the work of the Bureau of Foreign and Domestic Commerce in the domestic field is of great and growing importance, the promotion of export trade, which formerly was almost its sole activity, continues to constitute its largest field of service.

More than $50,000,000 worth of new business and savings in the foreign-trade field in a year when new business and savings had special significance—these are known accomplishments by the bureau; but they comprehend only a few of the past year's activities, for they take no account of those intangible services which make up so large a part of the labors of all units of the bureau organization. As "intangibles" can be listed the furnishing of information on foreign markets in general or on the suitability of a particular product to a particular locality abroad; assistance in adjusting commercial misunderstandings; explaining foreign tariff classifications, rates, and regulations; aiding in foreign trade-mark registration; advising of the financial standing and business integrity of foreign buyers and agents; and many other services which, because of their nature, preclude even an estimate of their value but which nevertheless represent in their totality a vast saving to business.

The typical examples of actual sales or savings in export trade which follow illustrate the range of industries served.

Agricultural implements.—In Italy bureau offices were successful in opening new markets for agricultural tractors; one American firm reported an export business there last year of $41,000.

Airplanes and airplane parts.—Shanghai is an airplane market of great potentiality and therefore the scene of strong foreign competition. One Michigan firm reported that with the help of the bureau it had sold to the Chinese Government $132,000 worth of its planes.

Six airplanes with a value of $150,000 were sold in the Netherland East Indies last year by a New York exporter. The part the bureau

played in this sale is adequately expressed by the American company: "It is very probable that the contracts might not have been obtained had it not been for the services which your organization was able to extend."

Automobiles, parts, and accessories.—By arranging an agency with a firm in Czechoslovakia the Prague office made possible an export business of $10,000 for a Michigan manufacturer of automobiles. In the same manner the Montreal office assisted in the sale of $15,000 worth of motor trucks in Canada.

A Belgian dealer in automobiles, unable to secure a satisfactory representation of an American car, was put in touch with an Indiana manufacturer. In its confirmation of this service the American company placed the business done through this connection at $80,000.

The trade commissioner at Calcutta assisted a Michigan motor corporation to establish an agency in India and in less than a year a $25,000 business has been done.

One large Illinois firm, organized for the exportation of all types of motor vehicles and their parts and accessories, has established through bureau aid 12 new foreign contacts and reports a business last year of $150,000 from them. Another American firm engaged in the sale of driving lights places the value of the business secured last year through the assistance rendered by the bureau at $50,000.

Bank fixtures.—A Texas manufacturer of bank fixtures found an outlet for his products in near-by Mexico through the cooperation of the American commercial attaché at Mexico City. He lists his sales to that country at $23,000.

Canned meats.—With the aid of the bureau organization a firm whose factory is located in Louisiana shipped to Mexico, Guatemala, and Colombia $10,000 worth of canned meats.

Chemicals.—A New York company has exported $100,000 worth of chemicals to an agent in Italy who was secured through the efforts of the Milan office. Bureau assistance enabled an Illinois firm to export $40,000 worth of cleansers and to make five new foreign connections.

A firm in Georgia places a value of $600,000 upon the results obtained through bureau cooperation and gives as a specific instance the securing by the Helsingfors office of a Finnish agent with whom business in chemicals amounting to $260,000 was done during the year.

Citrus fruits.—A company which exported fruit juice worth $25,000 to England last year writes: "The department has been invaluable to us in the formation of plans and methods of contact abroad." A Florida dealer reports that through bureau efforts he exported 5,000 cases of grapefruit, with a value of $25,000, to Canada last year. Exportation of $105,000 worth of canned grapefruit to Canada, United Kingdom, Germany, and South Africa and 22 new foreign connections provide another example of the tangible returns to American business of the bureau's efforts to encourage the export of agricultural and horticultural commodities.

In reporting business of $31,000 in citrus fruits and juices, made possible through bureau efforts, another Florida grower added: "Wish to take this opportunity to thank you for the service which you are rendering the canners of this State."

Confectionery.—A Tennessee candy manufacturer was assisted in exporting $30,000 worth of his products to South Africa, Egypt, and Germany last year.

Cooperage.—A Texas cooperage firm established connections in Scotland, France, and Spain, and reports that it has done an export business of $130,000 in the last year.

Cosmetics.—Commenting on a Canadian agency connection that was made through the Winnipeg office an American manufacturer of cosmetics says: "While our contract with this firm was signed just 3 months ago, it was not until 10 days ago that we got things ready for business. In that short interval they have sold $500 worth of our products. We expect to do about $12,000 per year business with them."

Cotton.—By aiding a Texas cotton firm in the establishment of four European connections the bureau made possible an export business of $1,000,000. Another southern cotton dealer sold to an agent in Greece, who was suggested by the Athens office, $25,000 worth of raw baled cotton.

Cotton linters.—Through the assistance of the commercial attaché at Berne and the cooperation of the Atlanta district office, a Georgia organization shipped $26,800 worth of cotton linters to Switzerland.

Cotton waste.—A southern manufacturer marketed $10,000 worth of cotton waste in Germany through an agent suggested by the Berlin office.

Electric refrigerators.—The commercial attaché's office in Tokyo secured a representative in Japan for a large American manufacturer of electric refrigerators from whom orders amounting to $25,000 have been received. Another exporter of electric refrigerators gives $69,000 as his business with a French firm recommended by the Paris office.

Fishery products.—The Tokyo office made possible the exportation to Japan of $93,000 worth of sea food by one Texas concern.

Flour.—Through six new connections established with bureau aid a southwestern milling company exported $100,000 worth of flour to Europe, the Caribbean area, and the Far East. A Texas miller reports that assistance from the commercial attaché at Berlin enabled him to sell $10,000 worth of flour to Germany.

Seven new foreign connections in Latin America, which were secured through the cooperation of bureau representatives there, were reported by a western flour mill to have made possible an export business last year of $425,000. The Panama office was able to suggest an agency for American flour and in less than a year 22,000 sacks have been exported, valued at $35,500.

Fruits other than citrus.—As a direct result of representations made by the commercial attaché in Warsaw, for the first time the Polish import contingent for American fruit was increased to a point that makes it possible for our exporters to meet the demand in that country. The increase in these contingents ranges from 50 to 200 per cent.

Thirty-two thousand dollars worth of canned fruit was sold by one Michigan exporter to a Finnish firm suggested by the commercial attaché at Helsingfors; in the same manner $60,000 worth of

fresh apples was sold to the same country by a western fruit growers' association.

Glassware.—A glassware manufacturer reports orders totaling $50,000 through six new foreign connections made at the suggestion of bureau representatives.

Industrial machinery.—Fifty thousand dollars is reported by a Kansas manufacturer of industrial machinery as the amount of export business done with Argentina and South Africa through the aid of bureau offices there.

Lard and bacon.—A Finnish agent, secured through the action of the Helsingfors office, purchased last year $25,000 worth of American lard and bacon.

Leather.—Eighty-five thousand dollars worth of leather sold to eight new foreign connections represents the benefit to one Michigan tanner from bureau cooperation.

Livestock.—Formerly the breeding cattle imported into Brazil came almost exclusively from Europe. Due to the efforts of the Rio de Janeiro office, however, Jersey cattle valued at $10,000 were exported in one transaction to that country last year.

Four connections in Latin America arranged through bureau offices have resulted in the sale of $16,000 worth of horses and mules by a western company.

Machines and machinery.—Greek agents suggested by the Athens office have purchased $125,000 worth of excavating machinery from one American exporter.

Motion-picture apparatus.—The Wellington office brought to the attention of a New Zealand firm the desirability of an agency for talking-picture reproducing apparatus, and as a result a business of $160,000 has been transacted to date.

Motion-picture cameras and projectors have entered the markets of Switzerland. Germany, France, and India to the value of $35,000, and the American manufacturer securing these orders gives the bureau full credit.

Motor cycles.—Two of the bureau's foreign offices were able to make connections for an American motor-cycle manufacturer through which he has done a business of $60,000.

Naval stores.—An export business of $280,500 in naval stores to Argentina, Chile, and Italy resulted from the cooperation of bureau offices in those countries. Forty thousand dollars worth of rosin was shipped from Alabama to Japan, Denmark, and Belgium to agents suggested by Foreign Commerce officers stationed there.

Paper and paper products.—With the encouragement of bureau offices, Latin America bought $15,000 worth of Louisiana paper last year.

Petroleum.—"Especially in India your services [in the sale of petroleum products] have been such that we are at present doing a business in excess of a million dollars," is another testimonial to the ability of the foreign offices in trade-promotion work.

The Paris office was instrumental in securing for an American petroleum company an agency with which $250,000 worth of business has been done.

Pharmaceutical products.—Dental cream and pharmaceutical products worth $125,000 have been sold by two American exporters to a Canadian agent whose selection was suggested by the Toronto office.

Potatoes.—During the summer of 1929 it became apparent that western Canada would have a short potato crop. The deficit was partially made up by the importation of 200 carloads of American potatoes arranged by the Winnipeg office with the aid of five district offices.

Radio equipment.—The Buenos Aires office aided an Illinois radio exporter in obtaining an agent in that city. The success of this connection is indicated by the statement of the American firm: "We have done about $30,000 worth of radio business with them since the agency was established three months ago."

Rice.—Argentina, Denmark, Netherlands, and Chile have proved, during the past year, potential markets for American rice. One Louisiana firm alone reported $200,000 in sales to these countries through bureau efforts.

Rubber and rubber products.—A Massachusetts rubber company estimates the value of the assistance rendered by the bureau at $27,000. Another New England firm gives $455,000 as the amount of business directly resulting from bureau activities.

Sardines.—An American firm shipped 200 cases of sardines to an agent in Chile who refused to accept the documents. Since these sardines were actually in prime condition on arrival, the Santiago office was able to dispose of the entire shipment, which, if left in the customhouse much longer, would have been a total loss to the exporter.

Shoes.—A Boston footwear concern gives $35,000 as the aggregate of business done in Europe through bureau information and service.

Steel products.—A New York manufacturer credits the Buenos Aires and Rio de Janeiro offices with the sale of $20,000 worth of steel products to merchants in Argentina and Brazil.

Speedboats.—Bureau field men helped one manufacturer of speedboats to secure 10 new foreign representatives and transact a business through them of $326,000.

Sugar.—A southern refiner writes: "We were about to ship sugar on consignment to Scandinavia, but information from the bureau and other sources indicated the inadvisability of doing so and thereby saved us probably $50,000."

Textiles.—The largest amount reported by any single textile establishment was $685,000, which a Carolina company gave as the value of export business secured directly or indirectly as a result of information supplied by the bureau.

A textile agency established by an Illinois export house on the recommendation of the trade commissioner at Johannesburg has resulted in a yearly business of $15,000 with South Africa.

Through the action of the trade commissioner in Toronto a North Carolina hosiery mill was placed in touch with a prospective agent, arrangements closed, and $15,000 worth of goods sold in Canada in less than a year, with prospects of continued and larger business.

The attention of a Danish importer was called by the Copenhagen office to the practicability of an agency for American knitted underwear. As a result, he is now doing a yearly business of $30,000.

Eight thousand dollars worth of jute bagging was exported to Canada last year by a Virginia concern at the suggestion and with the cooperation of bureau offices in the Dominion.

Tobacco.—Suggestions of Foreign Commerce officers in China and England have resulted in $100,000 worth of tobacco being sold to these two countries by one American firm.

Through the efforts of the Bucharest office the Rumanian governmental tobacco monopoly placed a trial order for American cigarettes. No American cigarettes had previously been on the market. With the initial and additional orders this represents a business of $10,000 to date, with very good possibilities for the future.

Well-drilling machinery.—In India and China $10,000 worth of well-drilling machinery has been sold by an Iowa manufacturer through the assistance of bureau personnel there.

Yarns.—The Santiago office was instrumental in securing an agency in Chile for a large southern manufacturer of yarns. At the close of the year the American firm reported resulting business at $72,000.

Miscellaneous.—The trade commissioner in Hamburg succeeded in arranging a connection between a merchant in that port and a west coast exporter and $10,000 worth of chicken, duck, and goose feathers was exported.

Through prompt action and cooperation on the part of the Budapest office an American firm of contractors was awarded the contract for the construction of 8 miles of road in Hungary at a figure of $263,000.

One steamship company, speaking of its export trade in citrus fruits, writes: "At least 50,000 boxes may conservatively be credited to data secured through the Jacksonville office." At an average value of $4 per box, this new business was worth $200,000. Another steamship company writes: "The benefits * * * have increased business to such an extent that it has warranted the increase of services we are rendering this port," and gives $150,000 as the value of new business accruing from bureau efforts.

The Toronto office helped to establish a Canadian agent for American foodstuffs such as meats, macaroni, rice, and cereals; $355,000 worth of business has been done during the past year.

AID FOR FIRMS IN ALL PARTS OF THE UNITED STATES

The bureau's activities extend to all States of the Union. The producer and exporter of commodities in every section has the advantage of its services, and the brief list of transactions cited below shows that they have been quick to avail themselves of these facilities.

Alabama commodities that were exported last year through bureau efforts include knitted underwear to the Union of South Africa, rosin to Japan, Belgium, and Denmark, wheat flour to Latin America, and lumber to practically every part of the world. *Arkansas* rice was exported to Cuba and Great Britain, piston rings to Rumania and New Mexico, and hardware to Great Britain and the Netherlands.

The services of the bureau were much used by west coast merchants last year, and *California* exported redwood timber and canned fish to Java and the Straits Settlements, tractors to Belgium, radio equipment to South Africa, electric-lighting fixtures and canned foodstuffs to China, oil burners to Sweden, olives to Canada, fresh

apples to Europe, dried fruit to Argentina and the Gold Coast (West Africa), and adding machines to India. Honey was exported from *Colorado* to Germany, United Kingdom, and France, silver-fox furs have been sent abroad, and beans shipped to Cuba. *Connecticut* exports included brass goods to Argentina, hardware specialties and tools to Norway, and rubber specialties to Canada and the British West Indies.

The bureau was instrumental in the selling of *Delaware* linoleum and other floor coverings to New Zealand, China, Australia, South Africa, and Porto Rico, lacquers, paints, varnishes, and insecticides to Colombia, and cotton sheet linters to Italy.

Florida citrus fruits went to practically every fruit-importing country of commercial significance, but bureau aid to the State did not stop there, as a record of lumber to Panama, United Kingdom, and Germany, sponges to South America, asphalt to Peru and Brazil, and machinery to Cuba would indicate.

Georgia sent cotton waste to Europe, walnut timber to the Netherlands, and tallow and grease to Cuba.

Illinois shipments included crusher machinery to the Netherlands and New Zealand, poultry brooders to England, furnaces to Canada, automobiles to Belgium, Cuba, and the Straits Settlements, outboard motors to Poland and Egypt, electric washing machines to New Zealand, silk hosiery to Argentina, pistons to the Netherlands, Java, and Germany, and confectionery to Africa. Cereals and grains from *Iowa* were imported by Guatemala and Colombia merchants at the instance of Foreign Commerce representatives located in these countries; also, fountain pens and mechanical pencils were sent to South Africa and Manchuria, concrete-pipe machinery to Australia, gasoline, oil, and gas-tank fittings to Canada, and hoists to Argentina.

Kansas sold razor-blade sharpeners to Latin America, flour to Venezuela, Cuba, British Honduras, Italy, and Colombia, batteries to France and Belgium, and glassware to the West Indies and Panama. *Kentucky* tobacco and cigarettes were put on the market in Switzerland and Canada, truck bodies were shipped to Canada, machinery and lumber to the Union of South Africa, and agricultural implements to Italy.

Louisiana hosiery found buyers in Peru and Colombia, caulking cotton was sold in Canada, and softwood lumber to South America.

Shipments of *Maine* granite were made to several foreign countries. *Maryland* business concerns found markets in China and Peru for paint; in Rumania, Denmark, New Zealand, Latvia, Egypt, and the Straits Settlements for portable electrical tools; in Java for fertilizers; and in France for petroleum and petroleum products. *Michigan* exporters disposed of rubber shoes to Czechoslovakia, Denmark, Sweden, and Uruguay, phonograph records to Sweden, pharmaceutical specialties to France, tires to Java, vacuum cleaners to Canada, metal-working machinery to Germany, motor cycles and parts to Norway and Greece, electrical instruments to South Africa and Peru, silk hosiery to Panama, lumber to Scotland, and automatic stamping machines to Sweden. Michigan manufacturers also established agencies for and made sales of engineers' supplies in New Zealand, humidors in Canada, electrical appliances in Sweden, and

feedstuffs in Venezuela. *Minnesota* paper was sold to Canada, feedstuffs to Europe, industrial machinery to Latin America and Australia, farm tractors to Germany, marine motors to Netherland East Indies and Chile, poultry to South Africa, fur-bearing animals to Sweden and the Netherlands, medicines and perfumes to Latin America, wheat flour to Finland and Venezuela, and canned peas and corn to England and Canada. One *Mississippi* manufacturer sold truck bodies in Cuba, and another sold iodine products to Egypt, Latin America, and Italy. *Missouri* paints found a market in Mexico, fire bricks in Norway, Canada, France, and Italy, motor cars in Manchuria and Denmark, X-ray and dark-room equipment and airplane parts in Canada, electric fans in India, and shoe machinery in Mexico.

From *Nebraska* index tabs went to India and Chile, ice-making and refrigerating machines to several foreign countries, concrete mixers to South Africa, automobile tools to France, Switzerland, and Peru, and incubators to Argentina. Soap and toilet preparations from *New Hampshire* have been furnished to Canada and engineers' supplies to Germany. *New Jersey* exports made possible through assistance extended by the bureau include paints and varnishes to Colombia, toilet preparations to the Union of South Africa, wax paper and beverages to Latin America, refrigeration machinery to India and the Straits Settlements, and leather cloth to the Orient. A *New Mexico* firm reports extensive shipments of alfalfa meal to Scotland and England. Shipments of *New York* chemicals have been made to the Netherland East Indies and Canada, naval stores to Japan, paper products to China and the Philippines, steam shovels to Europe and South Africa, gasoline stoves and heaters to Latvia and Rumania, snow plows to Poland, rubber-manufacturing machinery to Europe, China, Japan, and Mexico, paste to England, and electric-lighting appliances to Australia, New Zealand, and Latin America. The bureau made possible the exportation from *North Carolina* of mercerized cotton yarn to Australia, Argentina, Uruguay, England, and the Scandinavian countries, crushed oyster shells to England and Belgium, glassware to Cuba, hosiery to Canada and Cuba, and tobacco to Belgium and Germany. *North Dakota* sent carloads of potatoes to Canada.

Satisfactory distributors were found for *Ohio* producers of cutlery and kindred lines in Latin America and Asia; spark plugs in Denmark, Switzerland, and Italy; paint-spraying equipment in Europe and Africa; windmills and towers in Argentina and Greece; lime in Cuba; industrial machinery in Australia and South America; and motor vehicles in Paraguay. Flour was purchased by Cuba from *Oklahoma*, as were also large quantities of glassware by Latin America; and *Oregon* concerns shipped swimming suits to Chile and the Straits Settlements and lumber to Europe.

Pennsylvania manufacturers have opened up, with bureau aid, new markets for ventilating equipment in China; heavy jacks in India; machines and tools in France; pipe and pipe fittings in Canada and Guatemala; transmission belting in England; brass products in Java; fruit in Europe; mine appliances in Brazil, Japan, China, and Turkey; electrical products in England, Australia, and Africa; vending machines in Canada and Uruguay; rubber products in Germany; and glassware in Australia, the Philippines, China, and

Latin America, and an agency was established for a Pittsburgh manufacturer of gas masks in Turkey.

Rhode Island shipped to Canada automobile accessories, hardware and hardware specialties, and belt hooks.

Glassware from *South Carolina* was sent to Cuba, as well as yarns to Canada and lumber to Italy.

Sales of *Tennessee* lumber were concluded with merchants in all parts of Europe and in Japan; hosiery was sold in Peru and Norway; cooperage in England, Canada, and Cuba; cotton in Europe; agricultural implements in the West Indies; stoves in Canada; shoes in Mexico and China; and paint in Spain. The State of *Texas* benefited from bureau services through sales of oak staves to France; wheat flour to Latin America and the West Indies; industrial and mining chemicals to Mexico; camp furnishings, tents, and awnings to Colombia; lubricating oils to Porto Rico; tank cars to Canada and Mexico; sulphur to Australia and Europe; cotton to Greece and northern Europe; extracts and flavoring sirups to Mexico; rice to South America and Greece; canned shrimp to Germany and Italy; livestock to Guatemala; fire-fighting equipment, groceries, paints, and roofings to Mexico; and hardware to Central America.

The bureau assisted honey exporters of *Utah* in establishing agencies in Germany, England, and France, and also was successful in finding connections abroad for a manufacturer of automatic stamping machines.

Last year bureau aid made possible the shipment to Canada of building materials, musical instruments, and hotel supplies manufactured in *Vermont*. *Virginia* marketed fruits in Europe, trunks and hand luggage in Argentina, furniture in Central and South America, tobacco in Europe, stoves in Canada, peanuts in the West Indies, rails in South America, lumber in the Netherlands and Norway, and paper and paper products in South Africa.

Cargoes of lumber to the United Kingdom, continental Europe, Australia, South America, and China; flour to Hawaii; locks to Japan; felt hats to South America; and candy to Java represent but a few of the results obtained by exporters in the State of *Washington*. *West Virginia* firms were assisted in exporting marble to Canada, agricultural implements to Poland, glassware to the Dominican Republic, radio equipment to Porto Rico, and dyestuffs to Argentina. *Wisconsin* cranes and hoists went to Italy; aluminum products to Denmark; milling machinery to Hungary; electrical equipment to China and New Zealand; hosiery to Australia; automobile jacks to Turkey, Czechoslovakia, and Germany; tractors to Italy; other agricultural implements to France; filing cabinets to Norway; batteries to Peru; concrete mixers and centrifugal pumps to Canada, Egypt, and Turkey; rubber clothing, boots and shoes to Sweden and Germany; and malted milk to New Zealand.

NEEDED EXPANSION OF BUREAU'S ACTIVITIES

Demands upon the bureau for assistance in solving some of the perplexing problems which confront American business men in their domestic trading far exceed the funds available in the appropriation for Domestic Commerce. The majority of these requests represent problems which business men themselves are unable to solve either

individually or through their trade associations. There is real need for a governmental organization which can gather certain types of information and in which the public has complete trust as to the confidential treatment of the returns and lack of bias in their analysis. Trade associations and other business groups would gladly aid financially in much of this work if the Secretary of Commerce were authorized to accept contributions under proper safeguards. If this authorization could be obtained, it would conserve public moneys and greatly enlarge the usefulness of the bureau. Authorizations of this nature are in force in the Department of Agriculture, the Bureau of Standards, and other governmental units.

One of the major problems before business to-day is the rising cost of bringing commodities from the producer to the consumer. These costs have been mounting for several years, and in a considerable measure they offset the savings effected through lowered production costs. The work of the bureau during the past year in developing methods by which the distributor may know what it costs him to handle individual commodities and to perform individual operations has met with widespread approval. There is urgent need for more research along these lines, and the success already attained in this field would seem to justify a material strengthening of this work.

Because of an overproduction in the industry, during the past year the aeronautics trade division of the bureau was called upon on numerous occasions for assistance in domestic marketing problems. Requests for help in export-sales promotion are so heavy that it has been impossible to devote to domestic sales matters the attention which their importance warrants. With additional personnel in the division more time could be spent in the field organizing this phase of the district office work, endeavoring to have remedied some of the present sales practices which are a detriment to the industry, and compiling information upon which the industry can base sales campaigns.

Another field as yet untouched by the aeronautics trade division but for which there has been a demand is the making of a survey with regard to potentialities for passenger, freight, and express traffic for the airlines. Data of value in this connection could be obtained by means of aeronautics specialists in the district offices.

Organization of a travel unit for the purpose of encouraging foreigners to visit the United States and of bringing foreign commercial groups here would do much to stimulate our invisible exports and at the same time expand visible exports by establishing new and closer business relations. It would also stimulate travel on ships flying the American flag.

The dependence of the major industrial nations upon sources of supply located outside their political domain has been the cause, in recent years, of a determined effort on the part of practically all such nations to obtain commercial control of strategic mineral deposits throughout the world. Subsidies in one form or another have been granted by many governments as an aid to their nationals in securing and maintaining control of certain essential minerals. Manufacturers and consumers in the United States who are obliged to import a large part of their raw-material requirements are now seeking, by purchase of deposits or investment in mining properties in foreign countries, to assure their companies of adequate future

supplies. The bureau, through its trade commissioners, can be of considerable assistance in facilitating the efforts of American mining and manufacturing companies.

In last year's report it was indicated that the bureau was desirous of making more extended studies of the present and future supply and supplementary sources of the raw materials that now represent two-thirds of our chemical imports. The requisite appropriation was not available to carry on these basic studies in connection with the hundreds of items involved. It is nevertheless a problem of such consequence that the bureau's desire for research in this field is reiterated.

The American lumber industry, eighth among industrial groups in value of output and the producer of one-half of the world's sawn lumber, is well supplied with production data but is much in need of a great deal more distribution information than now available. Particularly does the trade want an annual quantitative survey of distribution, by States, that will embrace movement through retailers and consumption by railroads and by all important factory industries as well as in construction. Special surveys of distribution costs and the effect of seasonal factors on sales also are desired.

During the past year the bureau carried out surveys of potential buyers in the United States for two important lines of industrial machinery, plotting the country by industries using the particular articles under study. There are indications that the bureau will be called on for much more of the same kind of research in the future, and provision for it should be made. It is hoped that through the use of census and other data it will be possible to analyze industry's purchases of machinery and to develop other similar indices, sometimes on the dollar basis, sometimes on the basis of density of industrial activities per square mile, and finally to issue maps and other tabular data that will guide sales managers in establishing selling and advertising policies and assist them in the elimination of some of the wastes with which they now struggle.

The junk pile has within the last few years had a serious, but at times unrecognized, effect upon the consumption of primary nonferrous metals. The inability of producers to forecast accurately the tonnage of secondary metals that may enter the market at any given time and the apparent unwillingness of the various factions involved to cooperate, to the end that accurate market data of value to all may be available, open to the bureau a new avenue for service.

There is pressing need for an immediate marshalling of all information relating to potential traffic bearing on present and proposed inland-waterway projects. Abundant pledges of cooperation by private interests have been received. Were funds to be provided for undertaking a survey of this character, the work could be carried out conjointly with the War Department.

The fertilizer industry is becoming so important in the United States that a separate section should be set up in the bureau to look after its interests and provide increased informational services. The urgent requests of the industry for more information can not be met by the staff now available for this purpose.

One of the most important industries centered in the South is the production of turpentine and rosin, the major items among "naval

stores." The South supplies 60 per cent of the world demand for these two products. Changing conditions have affected sales, which to-day are only two-thirds of what they were 30 years ago. The trade has asked the bureau to undertake a survey to discover causes and remedies for this situation.

Familiarity with the standard specifications promulgated by foreign countries is necessary to the successful marketing of many commodities abroad. Lack of acquaintance with the language in which the specifications are issued often handicaps the American exporter seeking to extend his business to these areas. Additional personnel to review, translate into English, and prepare for publication selected foreign commodity specifications would permit the bureau to provide this specialized service to American industry.

THE FOREIGN COMMERCE SERVICE

The bureau was represented abroad last year by 56 offices maintained in the principal trade centers of 44 countries, to which were assigned 188 members of the Foreign Commerce Service. This personnel consisted of 37 commercial attachés, 23 assistant commercial attachés, 54 trade commissioners, 52 assistant trade commissioners, and 22 American clerks.

Changing conditions in the United States during the year, with resultant uncertainty, caused the American business community to call upon the Foreign Commerce Service as never before. In one activity alone, that of answering direct inquiries received from individual concerns requesting market information and assistance in establishing connections with agents or purchasers abroad, a gain of 28 per cent was noted; over 40,000 of these "trade letters" were prepared.

The 4,672 prescribed periodic cables from the foreign offices during the year enabled the bureau to pass on to American business men timely information concerning the economic situation and market data for specific commodities throughout the world. These cabled advices were supplemented by mailed reports which aided the exporters of the United States in keeping abreast of conditions abroad affecting their particular interests.

TANGIBLE AND INTANGIBLE BENEFITS TO COMMERCE

The direct monetary benefits accruing from the work of the field officers were most substantial. Elsewhere in this report specific accomplishments are referred to and typical cases that have been brought to the bureau's attention are cited. In this connection it should perhaps be noted that the field offices were of assistance in establishing more than 1,600 new agency and sales connections abroad for American exporters last year.

In the category of activities whose results are intangible might be placed the supplying of advance information which has prevented useless expenditure upon sales campaigns, the saving of losses where goods had been ordered or consigned, and friendly intercession where the difficulties surrounding a transaction had already become involved. All of these have a very real value but one not measurable in definite figures.

COORDINATION AND UNIFICATION OF FIELD WORK

Throughout the year continuous and effective endeavor was made to further coordinate the work of the Foreign Commerce Service with the domestic work of the bureau organization. As a consequence, the district offices in this country and the field offices abroad have become more intimately linked, making the whole bureau organization a more closely knit unit.

In line with this desire for coordinated and unified effort, four regional conferences of Foreign Commerce officers were held during the year. The first of these was at Buenos Aires in January, when representatives from a number of the offices in Latin America gathered to discuss problems of mutual interest. The Canadian offices held a meeting at Ottawa early in March; and in May two gatherings were convened, one in Stockholm for the four offices in the Baltic-Scandinavian area and one at Panama City for the Caribbean and other Latin American offices which had not participated in the conference at Buenos Aires. These regional meetings have been productive of ideas for more efficient methods of dealing with the problems which continually arise, and are of further distinct benefit in helping field officers to become familiar with conditions in areas outside but contiguous to the territory to which they are assigned.

FOREIGN EXPERIENCE SHARED DIRECTLY WITH PUBLIC

Field officers upon returning to the United States for leave or reassignment visit the principal commercial centers and confer with individuals and organizations interested in foreign trade. In this way the valuable facts and impressions which they have gathered abroad are made directly available to the public. That these opportunities to obtain first-hand information are greatly appreciated is evidenced by the growing demand for such conferences. During the past year 39 returned Foreign Service officers visited an average of 12 cities each, and held an average of 26 interviews in each place, besides giving talks by radio and addressing export clubs, chambers of commerce, and other trade organizations.

Another means utilized to promote personal contact between the bureau and industry is by letters of introduction for Americans traveling abroad on business and for foreign buyers visiting the United States. The bureau and district offices issued 465 such letters to persons in this country, and these were presented at one or more of the foreign offices where every effort was put forth to supply needed local information, make introductions to local firms, and aid in other ways. Conversely, the foreign offices issued 411 letters of introduction to buyers in their territories contemplating travel in the United States, and these prospective purchasers upon arrival were put in touch by the Washington and district offices with firms which could supply their wants. There were also numerous trade delegations and other visiting groups of foreign business men for which bureau personnel planned itineraries and otherwise facilitated the establishment of contacts while in the United States.

During 1929–30 a greater number of officers left the Foreign Commerce Service to accept other positions than in any year since 1925. More than half of the men thus lost to the organization were of the rank of commercial attaché or trade commissioner. Although replacement of so large a percentage of trained personnel creates a special problem in the administration of the bureau, it nevertheless has its gratifying aspect also, since it can be considered a tribute by American business to the high caliber of the men we are sending to promote its interests overseas.

WORK OF THE DISTRICT OFFICES

The bureau started the fiscal year with 29 district and 48 cooperative offices throughout the United States. In September new district offices were established at Buffalo and Dallas, but no additional cooperative offices were opened.

Essentially, the district office is the Bureau of Foreign and Domestic Commerce in miniature. In its particular territory it is the stimulator and developer of foreign trade; it brings the individual manufacturer and merchant into immediate and personal contact with the bureau's work; it "retails" the information which the bureau at Washington "wholesales." In carrying out its functions it is constantly interesting in the technique of foreign-trade American firms which have not previously had a share in our Nation's exports. One Delaware firm, after explaining that the bureau office had been worth $25,000 to it in new sales and savings, stated: "We owe our entry and participation in foreign trade wholly to the suggestion and cooperation of the Wilmington district office."

RECORD NUMBER OF SERVICES LAST YEAR

The 31 district offices in 1929–30 rendered 3,214,278 commercial services, compared with 2,944,890 in the preceding year, the record number up to that time. This total includes the distribution of 911,537 copies of "foreign-trade opportunities," which have to do with specific openings throughout the world for American business men to sell goods or to establish commercial relations, reported by consular officers of the Department of State and the personnel of the Foreign Commerce Service. Many firms have indicated voluntarily to the bureau that these trade leads have resulted in very satisfactory foreign business, and some go so far as to say that their entire export business is founded on this service. As a New England manufacturer wrote: "This company is to-day shipping into 48 foreign countries where we have established good connections, and we are pleased to state that our success has been due solely to the foreign-trade opportunities received from your department."

"Trade lists," which supply the names and addresses of importers in foreign countries to whom it is possible for American exporters to sell goods, were distributed to the number of 698,196 last year. These lists cover every country of the world and practically every line of business. Regarding the effectiveness of this type of service a manufacturer of chemicals says: "Our annual export business now runs considerably over a half million dollars a year. Your depart-

ment has contributed in large measure toward the building up of this business, and we are leaning heavily upon you now to maintain it. As you know, we are constantly drawing upon you for trade lists and other information." An electrical manufacturer writes: "Last year we increased our overseas business approximately 25 per cent, a large proportion of this increase, we know, being the result of the lists that we received from the bureau."

FACE-TO-FACE CONTACT BETWEEN BUREAU AND PUBLIC

One hundred and fifty-three thousand persons visited the district offices last year. Many of them brought complicated export problems for solution; some came to confer with Foreign Service representatives of both the Department of Commerce and the Department of State, and others came to meet foreign business men traveling in this country to purchase American products. The district office performs a distinct service in bringing together foreign buyer and local seller, local manufacturer and foreign agent. An Ohio firm informs the bureau that one shipment, made as a result of being put in touch with visitors from abroad by a district office, amounted to $180,000.

Personal contact of a different, but very effective, character is achieved in the foreign-trade meetings which the district and cooperative offices arrange. These meetings are conducted along the lines of a convention, with group and individual conferences, to which exporters bring their problems for consideration by bureau experts sent out from Washington and the Foreign Service. In nearly every case the program is arranged and the bulk of the preliminary work is done by the manager of the local office.

Meetings of this kind were held the past year at Boston, Houston, Jacksonville, Atlanta, Birmingham, Dallas, Wichita, St. Louis, Los Angeles, Cleveland, Buffalo, Charlotte, and other cities. As an index of their value, the following is quoted from a letter received from a southern correspondent:

> I think it would be an injustice if I did not personally tell you how great was the contribution of the Houston district office to the success of the Southwest Foreign Trade Conference recently concluded here. Your men very efficiently carried far more than their share of the burden, and to them is due the honor for making the second convention three times as large as the first one.

RÔLE OF THE COOPERATIVE OFFICE IN TRADE PROMOTION

The cooperative offices which are maintained in 48 commercial organizations throughout the United States contribute materially to the success of the bureau. They work very closely with the district offices. The effectiveness of their activities is seen in known results. Last year certain of the firms served by the cooperative office maintained in the Cleveland Chamber of Commerce reported the securing of nearly $400,000 worth of business through the aid furnished by that office; likewise the office maintained in the import and export bureau of the Association of Commerce in Baltimore was credited with $335,000 worth of new business by its contacts; and firms furnished with bureau information by the cooperative office in the Cincinnati Chamber of Commerce report business abroad to the extent of $120,000 directly traceable to this assistance.

Thus it will be seen that the bureau through its chain of district and cooperative offices is linked up with all the more important

industrial centers of the country, and that these 79 "service stations" play an important part in the expansion of the Nation's foreign trade.

NEW OFFICES AND ADDITIONAL PERSONNEL CALLED FOR

How rapidly demands upon the district offices are mounting has been pointed out. It is necessary that further assistance be provided, as well as increased funds for travel. At the present time there is not a sufficient sum available for travel use, which means a serious curtailment of the productivity and effectiveness of these offices. The district offices must receive some relief if they are to cope successfully and expeditiously with the increased work devolving upon them.

New district offices should be established to round out the district-office service; and funds should be provided also for placing assistance in some of the more important cooperative offices where fully equipped district-office service is not thought necessary.

CONCRETE COMMODITY SERVICE FOR AMERICAN INDUSTRIES

AERONAUTICS TRADE DIVISION

In its first year as a separate member of the bureau organization the aeronautics trade division, which previously had functioned as a section of the transportation division, faced problems of unusual complexity. Even with a curtailment of output before the financial crisis of October, 1929, the American aircraft industry found itself overproduced toward the close of the calendar year, with consequent keener interest in export outlets and resultant heavy demands upon the division for assistance. A conservative estimate indicates that the division was associated in some way—through its own initiative or in its capacity of clearing house for work accomplished in behalf of the industry by foreign offices of the Departments of Commerce and of State—with 50 per cent of the aeronautic exports during the fiscal year 1929–30.

Because of the newness of the industry there are lacking both the background of trade experience and the cumulative data available to older activities. To meet the need for foreign-market information a Handbook for the Aeronautic Exporter was prepared by the division and published by the Aeronautical Chamber of Commerce, the industry's national organization. This Handbook is a loose-leaf service of basic data on each foreign market, with weekly supplements that keep the information current. It contains, in addition, for the use of the inexperienced exporter, a section on export procedure, covering foreign import duties, documentation, marine insurance, financial arrangements and credit, distributors' and dealers' agreements, and kindred topics, and another on "How to develop an export business" which discusses circularization of prospective distributors and purchasers, advertising, demonstrations, choice of traveling representatives, and types of distributive agencies.

Although its principal work was in the foreign field, the division was called upon for advice in connection with the domestic market because of the general sales depression. One of the largest holding companies in the industry was aided in a survey to ascertain the

proper locations for servicing facilities. With the cooperation of the bureau's field officers, the division was instrumental in bringing two foreign aeronautical missions to the United States and was intimately associated with their reception and the planning of suitable itineraries.

The division has become the outstanding source of information on foreign aeronautics. All pertinent foreign developments are reported in its weekly Foreign Aeronautical News, and special articles of greater length appear in Commerce Reports. Bulletins on airports in Latin America, Canada, and Italy were prepared and the first-mentioned has already been printed. Maps of airways in Latin America and Canada and lists of air services in the Dominion and the southern Republics were published. The foreign chapter of the Aircraft Yearbook of the Aeronautical Chamber of Commerce again was compiled in the division, and many contributions were made to other books and periodicals.

On the average, 90 replies a week were made to special inquiries on aeronautical subjects from American exporters, banks, trade organizations, and other private interests. The information on foreign governmental regulations and reviews of economic conditions abroad supplied by the division were found particularly useful to American companies in the extension of their services to other countries.

AGRICULTURAL IMPLEMENTS DIVISION

A greater volume of business than in any year in the history of the industry was recorded by the agricultural-implement manufacturers of the United States in 1929–30. Production reached $600,000,000, an increase of about 15 per cent over the preceding twelve-month; and exports approximated $150,000,000, an increase of 10 per cent. On the whole, the trade was exceptionally steady and the industry reaped the harvest of years of careful manufacturing and merchandising, both at home and abroad.

The agricultural implements division has played a major part in expanding the foreign trade in farm implements to its present large proportions. Over 250 specific trade opportunities for implement sales abroad were distributed through the division last year and resulted in new business for many firms. One manufacturer closed, with the cooperation of the bureau's foreign staff, an agency agreement for the sale of tractors in Italy that brought an initial order for six machines and will lead to an estimated $30,000 worth of sales in the first year.

Publication in Commerce Reports of the results of the survey of the implement situation in 20 leading world markets evoked much favorable comment from the trade. A bulletin on the market for dairy and barn equipment in South Africa was issued during the year, and one on the manufacture and sale of farm equipment in the United Kingdom will be released shortly.

Through the medium of special circulars, articles in Commerce Reports, and shorter items in the division's Implement and Tractor Notes the industry was kept currently informed of developments in the foreign implement situation. Excellent reports were received from consular officers, one of particular worth being a monthly report from the American consulate at Cobh, Irish Free State, on exports

of Irish tractors. This circular, the only available official publication dealing with the manufacture and sale of Irish tractors, was in great demand by persons both within and without the implement industry.

More frequently during the past year than ever before calls were received from representatives of implement manufacturers about to embark on sales campaigns in foreign markets. The division had opportunity, too, during the year of giving assistance to American investment houses.

AUTOMOTIVE DIVISION

Although production and exports in the automotive field during the year just closed were below those of 1928–29, bureau services to the industry increased 13 per cent, reflecting growing recognition of the automotive division as an outstanding source of authoritative marketing information. Because of the industry's special need this past year for quick facts, the division arranged with the automotive associations of the United States to transmit to them, on the same day as received from abroad, certain classes of trade news, the associations in turn to communicate this immediately to their members. Thus the information was but one or two days old when received by the manufacturers and exporters.

Five times as many special publications in the Trade Information and Trade Promotion series and twice as many special circulars calling the industry's attention to particular trade opportunities were prepared by the division as in the preceding year, and increased circulation was obtained for its numerous regular statistical releases, the demand for the two annual studies, World Production of Automobiles and World Census of Motor Vehicles, being now world-wide. So far as known, no compilations similar to these two are published by any other country. Additional sheets were distributed for inclusion in the division's Automotive Foreign Trade Manual, a loose-leaf foreign-marketing service kept current at all times.

Pioneering work through special automotive trade commissioners and the foreign staffs of the Departments of Commerce and State produced results of particular value. Advice from one of the bureau's South American offices led to an order for 96 trucks valued at $120,000; a trade opportunity submitted by a consular officer enabled a firm to sell $100,000 worth of motor boats; a dealership established through bureau aid was productive of an initial $30,000 order. Extension of these efforts, already begun, to markets now relatively undeveloped but potentially important will pave the way for later sales.

Statistics on foreign highways are being collected in greater volume and detail than ever before, making it possible for the highways section of the division to render real service in connection with the forthcoming International Road Congress to be held in Washington in October, 1930, and to act as a clearing house for stimulating universal interest in good roads.

Much has been done to consolidate closer relations with the industry by frequent trips to manufacturing centers and attendance at conferences and like gatherings by the personnel of the division, and returning Commerce and consular officers have contributed to this

same end by addressing automotive groups and conferring with company officials.

CHEMICAL DIVISION

Anticipation of approaching events is perhaps the greatest present need of the chemical industry and the outstanding type of service which the chemical division of the bureau is called upon to render, made necessary by the increasingly important rôle which the science of chemistry is playing in every line of industrial activity. Synthetic products are being developed to replace natural products at so rapid a pace that unpleasant economic consequences can easily overtake established commercial enterprises if the trend is not foreseen and properly appraised.

Because of this necessity for keeping abreast of the march of events abroad as well as at home, one of the principal services of the chemical division has been the supplying of information relative to competitive activities throughout the world, but especially in Europe. A steady flow of technical and commercial news of this character has been released in the form of weekly issues of World Trade Notes on Chemicals and Allied Products, more than 2,000 separate references to trade conditions having been thus published during the past year.

Further to anticipate the need for fundamental data, comprehensive surveys on paints and varnishes, polishes, toilet preparations, prepared medicines, dental preparations, veterinary products, essential oils, and explosives were issued as special mimeographed circulars. Domestic industry benefited greatly through these activities by being kept fully advised of developments in similar fields abroad. At the same time, the feature of foreign-trade promotion was stressed, with the result that overseas shipments of staples have been maintained and markets for many new products have been found—as an example, plastic paints, practically a new item, whose exports have reached gratifying proportions. The new Capital Theater in Singapore, one of the finest playhouses in the East, was decorated with American paint at a cost of $35,000, and the Alhambra Theater in the same city has just been renovated and decorated throughout with American paint. American tooth pastes and shaving creams set the standard the world over. French products offer the keenest competition, but the quality of American toiletries is becoming known and shipments are increasing even to European markets; and with the growing conception of personal hygiene larger sales may be looked for in less highly developed localities.

Bulletins on Germany, Great Britain, France, Italy, and Switzerland were added last year to the series of reviews begun earlier to meet the insistent demand for information on the part of bankers, economists, and others both within and without the chemical field, and bulletins now in press cover Poland and Czechoslovakia. In order the better to evaluate the foreign competitive situation, a further intensive study is under way analyzing the relative export positions of the United States and Germany in the world chemical trade.

Fertilizer developments, with particular reference to new plant-food materials and the development of synthetic nitrogen and domes-

tic potash resources, are given constant attention by the chemical division. An exhaustive study of potash resources and synthetic nitrogen production in Europe was made during the year by the chief of the division, and the assistant chief is at present in South America studying the Chilean nitrate situation.

Special attention was devoted during the past year to the chemical problems of the South and West. The division was instrumental in organizing an International Naval Stores Conference to promote the interests of southern turpentine and rosin. The ravages of the Mediterranean fruit fly stimulated research into the industrial utilization of citrus fruit; in cooperation with the bureau's Jacksonville office the chemical division furnished Florida growers with market data and other assistance which led to the establishment of citrus-oil plants and the manufacture of fertilizer material from the final residue. The work of several preceding years in assisting the development of a domestic tung-oil industry in the Gulf States was carried on with increased energy and with distinct evidences of ultimate success. Creation of a relatively small but flourishing chemical industry on the west coast has been aided, and it is evident that heavier demands will be made upon the division in the future from that part of the country.

Domestic distribution problems continue to be of significance in the work of the chemical division. A beginning has been made on a retail drug store survey in St. Louis, to be carried out in conjunction with the domestic commerce division of the bureau.

ELECTRICAL EQUIPMENT DIVISION

"I am fully assured of the unquestioned value of the radio figures, and consider the quarterly survey to be a very fine example of the possibilities of cooperative statistical work. At the present time I know of nothing which equals it." So wrote an official of the National Electrical Manufacturers Association concerning the quarterly survey of radio dealers' and wholesalers' stocks and sales, conducted jointly by that organization and the electrical equipment division of the bureau. From sales figures received, quotas by trading areas could be suggested.

Several subsidiary studies have developed coincidentally—one showing in great detail operations of radio dealers located in different parts of the United States, another to indicate what the radio industry means to the industries furnishing the raw materials. Encouraged by the success in the radio field, the division has inaugurated a similar survey of electrical heating appliances.

Minor studies were made of the materials entering into the manufacture of different electrical appliances and of uses for fractional horsepower motors. Cooperation with the panel-board section of the National Electrical Manufacturers Association has proved of mutual benefit, the division acting as a clearing house for quarterly figures on orders booked by manufacturers not members of the association.

These activities were confined to the domestic field. Regarding activities that related to foreign trade, the services begun in previous years were continued and expanded in 1929–30. Eight special circulars, giving electrical current characteristics (type, source,

available supply, etc.) for Uruguay, Egypt, Netherland East Indies, Cuba, Venezuela, Lithuania, Latvia, and Porto Rico, were issued, bringing up to 21 the number of countries for which these details have been published. It is hoped soon to combine all this material and data for the remaining countries of the world into a single volume that should be of unusual value to the American exporter of electrical appliances. Revision of the very popular bulletin on World Markets for Radio Apparatus is about completed and the new edition will appear early in the present year. Another publication that was well received by the industry was the tabulation showing the relative value of foreign markets for electrical goods; this is being used as a standard reference work by a large number of exporters.

Another important service is that which now gives to American exporters a complete story each month of our foreign shipments of electrical equipment, made possible by combining 20 separate mimeographed reports into one, effecting also a saving of three to four weeks in time. The special monthly circular on exports of electrical goods from Germany was supplemented last year, through the cooperation of the industry here, by similar figures from Great Britain, and an effort is being made to obtain this type of information from the other European manufacturing countries.

A gratifying increase is noted in the number of items appearing in the trade papers of other countries which are based upon the news releases on electrical developments in the United States sent to the bureau's foreign offices weekly through the courtesy of the National Electric Light Association.

Close cooperation has been given American telephone manufacturers in securing concessions for the operation of foreign telephone systems, and to other American companies interested in the operation of foreign public utilities. In several instances, the division has supplied data on electrical wiring codes in use in the United States which have been employed by foreign countries as a guide in drawing up their own electrical codes, making it possible for American manufacturers to market their products in those areas.

Specifications covering purchases to be made by the State Electricity Commission of Victoria, Australia, continue to be distributed by the electrical equipment division with entire satisfaction, and last year specifications of the Egyptian Government also were handled.

FOODSTUFFS DIVISION

Research occupied much of the time of the foodstuffs division last year. Some of the work was a continuation and expansion of activities already under way; much of it was new.

To the series of studies on food production and consumption in the United States were added a survey of the mayonnaise industry and one conducted in cooperation with kraut manufacturers, and their continuance as regular division activities is probable, as may also be the case with the survey of the jelly and jam industry now in progress. The division has just finished a study covering 30-year trends in the consumption of different classes of foodstuffs, and the assembling of data on per capita consumption for this period is finished. Means should be found for keeping this information cur-

rent, so that the trend curve from year to year can be plotted for the benefit of the trade.

Among the domestic-distribution studies, a new project was undertaken for the National Confectioners' Association on cost of distributing candy by manufacturers. All the statistical work has been done, and the information developed is now being analyzed by classes of goods and by territories. Extension of this type of research to other food manufactures is highly desirable.

The collection of monthly statistics on candy production has been improved. This work supplements the data presented in Confectionery Distribution in the United States, one of the major publications issued by the foodstuffs division last year.

Plans have been worked out whereby the studies of wholesale grocery distribution costs (first undertaken two years ago) will be carried out cooperatively with groups of wholesale grocers desirous of making use of the new methods of cost analysis which have been developed. Arrangements were made the past year with the Ohio Wholesale Grocers' Association and the Ohio State University for setting up cost analyses in that State. As its contribution, the foodstuffs division aided in making the first analysis of two or three houses, and it is expected that the Grocers' Association and the State University will carry on the work in the future. It is hoped to make similar arrangements in other States.

During the year a preliminary study was made of the cost of warehousing by wholesale grocery warehouses and a foundation laid for research on retail delivery costs. In both cases striking differences in cost of operation were discovered, and further work is needed in these fields. These and other of the domestic activities of the division were carried out in collaboration with the domestic commerce division.

The second of the handbooks on foreign tariff and import regulations affecting foodstuffs, a joint activity of the foodstuffs and tariff divisions, was released under the title "Canned Foods in Europe," and like the first of these handbooks (Fresh Fruits and Vegetables) published the preceding year has proved very useful to the trade. Part III of this series, entitled "Canned Foods in the Western Hemisphere," is now in press. It is hoped to continue this work until all foodstuff commodities are covered.

The citrus-fruit trade commissioner appointed last year completed a study of the principal agencies in Europe engaged in fruit distribution, with special attention to the distribution of and the prevailing methods of advertising and promoting trade in citrus fruits. A study was made, too, of the statistical information available in the principal ports and arrangements perfected for expanding the cable service on receipts and sales of citrus fruits in the leading European markets. During the year the division expanded its cable service on a number of other commodities, particularly fresh fruits, vegetable oils, and rice, and a fairly complete service of cable advices on stocks, prices, and market trends is now available on these.

Other surveys in the foreign field begun or finished last year include one of the margarine industry and one of the ice-cream industry of Europe; a study of the soap industry in Latin America; and a world survey of markets for fruit juices and fruit sirups. Besides

these and numerous other trade information bulletins, the division issued monographs on the Tobacco Trade of the Netherlands and Netherland East Indies, Foreign Trade in Fresh Fruits, and the Coffee Industry in Brazil.

The tobacco section of the division was active throughout the year, securing foreign connections for the industry in the distribution of leaf tobacco and its products. Bureau information also led to the sale last year of certain brands of cigarettes and smoking tobacco in six new countries.

The fur-animal industry—a phase of the livestock industry coming within the purview of this division—has grown rapidly in the past decade, and considerable interest has been aroused not only in the exportation of American breeding stock but also in current developments in foreign countries. To meet this need, world data are now being collected and furnished to about 250 breeders of fur-bearing animals in the United States.

HIDE AND LEATHER DIVISION

Accurate, timely information supplied by the hide and leather division enabled the American tanning industry early to visualize the problems brought about by depressed world conditions last year and to so put its house in order that its financial and statistical position to-day undoubtedly is improved and the industry looks with confidence to the future.

By intensive, well-directed effort American leather manufacturers secured their fair share of the reduced volume of international trade and obtained a wider-than-usual distribution of their products. American leather is now being sold in 100 countries. The series of analytical studies of world markets in Commerce Reports was continued and enlarged, and a 300-page review of the International Trade in Leather (among many other useful bulletins issued) was published as Trade Promotion Series No. 103. The general statistical services of the division also were considerably expanded. Through the efforts of the Advisory Committee of the Tanners' Council of America and encouragement from the division, an active export committee was organized in the council during the year.

The work of the leather-trade commissioner in Europe has been of increasing value to the tanning industry from the standpoint of technical developments and the expansion of foreign trade. Much help was received also from the assistant trade commissioner in Shanghai, China, who kept tanners in touch with conditions in the Far East, aided materially in securing better agency connections, and advised on merchandising methods best suited to that area.

Compilation of the World Raw Stock Manual, which was delayed this past year by lack of personnel, will be a major activity of the division in 1930–31 and when completed will present a summary of the livestock population, the trend toward increase or decrease of herds, and the international flow of trade in raw stocks for every country producing hides and skins in commercial quantities. Specimen sections of the manual have been pronounced by executives of the industry a most valuable indicator of world production and movement of raw hides and skins.

The division has maintained its interest in the marketing of reindeer skins from Alaska and has cooperated in the study of the utilization of the by-products of that industry. It has also been actively engaged in the study of new processes of tanning, both in Europe and in the United States, and has been called upon for much assistance and information along this line. Study of new foreign supplies of vegetable tanning materials was continued in cooperation with the leather section of the Bureau of Standards, and of future domestic supplies of these materials in cooperation with the Department of Agriculture and the committee of the American Leather Chemists Association. The work of the interdepartmental (Agriculture and Commerce) committee on the conservation of domestic raw hides and skins has received international notice. Much preparatory work was done during the past year, which should bear excellent results in the near future.

INDUSTRIAL MACHINERY DIVISION

Since 1922 the curve of American industrial-machinery exports has been generally upward, and for the fiscal year just closed shipments reached the record figure of $263,390,000. This showing is indeed gratifying in view of the trade retrogression that was everywhere apparent; even Great Britain—a dominant factor in the world machinery trade—did not maintain its previous year's total. Machinery manufacturers and exporters are calling more and more upon the bureau for assistance; last year there was in increase of 27 per cent in these requests.

On the domestic side, the machinery division, in collaboration with the domestic commerce division, conducted a survey of the mechanical equipment in particular industries, its relation to excess factory capacity, the trend in depreciation, and the influence of obsolescence. Much valuable information was developed. The division also made special analyses of the domestic marketing of machinery which already have proved of inestimable value to manufacturers in arriving at correct sales policies and in eliminating waste in distribution. These studies are attracting the interest of a very broad community, and it would seem that there will be a demand for much additional work of this character.

Of the established activities of the division, the Construction News service, by which American concerns are informed promptly of large construction projects all over the world, is becoming more highly appreciated; the mailing list therefor, which was 1,294 in November, 1929, has increased to over 1,600 with no circularization on the part of the division.

During the year the division published bulletins on the machinery markets of Mexico, Netherland East Indies, and Italy; sawmill and woodworking machinery in Mexico, Guatemala, Panama, Cuba, Porto Rico, Turkey, Greece, Egypt, South Africa, Australia, New Zealand, Philippine Islands, British Malaya, Netherland East Indies, Scandinavia and the Baltic States, Canada, and South America; dairy equipment in the United Kingdom and continental Europe; and a general review of foreign markets for irrigation machinery and equipment.

IRON-STEEL-HARDWARE DIVISION

In the calendar year 1929 the United States export trade in iron and steel products reached its highest level since the war, exceeding 3,000,000 gross tons in volume and $200,000,000 in value. In the six months since then the effects of the general world depression have become apparent, and for the fiscal year ended June 30, 1930, the American export aggregates were 2,671,000 tons and $178,100,000—declines of 14 per cent in tonnage and 11 per cent in value from 1928–29, despite which the United States maintained its relative position in the world export trade in iron and steel and suffered less from this drop in overseas shipments than countries more dependent upon foreign outlets. The iron and steel division increased its services to the industry 12 per cent over the preceding year and was active in rendering assistance in the sales of wire mesh for construction use, nonskid floor plates, oil stoves, razor-blade sharpening devices, scrap iron and steel, and tree supports in addition to its work with the more familiar classes of material. Exports of hardware and allied products reached a total value of $66,964,000.

Studies of world resources and supplies of iron ore also were an important feature of the year's work. The American industry as a whole is displaying unusual interest in foreign ore deposits, especially those not now being actively exploited, and the division repeatedly was called upon for information concerning known deposits throughout the world. Another phase of the division's activities which is steadily becoming more prominent is that having to do with the sources of the imports of steel-consuming countries; broad studies have been made in response to specific inquiries from the industry, and the material developed has met with a most gratifying reception.

The division assists the industry in maintaining its domestic market through the medium of statistical analyses of the monthly import trade. Approximately 75 reports of this character are issued regularly, besides many others prepared in response to individual requests. This, of course, is in addition to the constantly growing activity of the division in handling inquiries which relate solely to domestic commerce.

Four trade information bulletins were published during the year under the titles Iron and Steel Trade and Industry of Great Britain, Iron and Steel Industry and Trade of Canada, Markets for Fuel Oil Burners in Canada and Latin America, and Markets for Fuel Oil Burners in the Eastern Hemisphere. Two others, which will be off the press early in 1930–31, are devoted, respectively, to a survey of the markets of the Western Hemisphere for cooking and heating appliances and to a study of the Czechoslovak iron and steel industry and trade.

LUMBER DIVISION

The lumber division expanded and expedited its press-release service on export and import trade conditions and foreign lumber developments with gratifying results last year, bringing about a wider appreciation of the advantages of export outlets for American lumber mills.

A bulletin on Douglas fir, issued the previous year as the first of a series for foreign distribution by exporters, proved so popular that the trade has itself paid for a Spanish translation thereof for use in Spanish-speaking countries, and this is now in press. Manuscript for a similar bulletin on southern pine has been completed, and other woods will be covered later. These bulletins on the properties and uses of American woods, prepared in cooperation with the National Committee on Wood Utilization and written from the foreign consumer's viewpoint, will aid greatly in extending foreign sales.

Bulletins on lumber-buying methods in South America and in Germany, Spain, and Italy were issued and a like study for South Africa was prepared by field officers. The lumber-trade commissioner in Buenos Aires supplied numerous special reports and is at present at work upon a review of the lumber trade of Argentina and Uruguay.

The important service of aiding American exporters to secure satisfactory agency connections abroad has been continued. The division possesses the most complete file in the country of lumber exporters and foreign agents, and from it last year made 794 agency suggestions, most of which resulted in new, replacement, or trial connections. As lumber imported into the majority of countries is sold through foreign agents on yearly or longer contracts, the value of this service is at once apparent.

The work of the lumber division has been closely correlated with that of the National Committee on Wood Utilization of the Department of Commerce. The experience of both organizations is available to inquirers with trade problems. Studies by the committee on wood construction, treated lumber and timber, short lengths, small-dimension stock, seasoning, and sap stain have been called to the attention of exporters and of architects, engineers, consumers, and importers abroad; and a special study nearing completion on tropical construction will be similarly handled. Considerable information on the domestic lumber trade has been assembled, preliminary to studies of distribution within the United States to be undertaken when funds become available.

MINERALS DIVISION

A feature intangible in a sense but accounting for a considerable amount of the time of the minerals division last year was the increase in requests for division specialists to serve in a consulting capacity in matters (usually of an emergency character) involving problems of international scope. In this respect, silver, copper, asbestos, petroleum, and anthracite producers manifested a decided interest in the services of the bureau.

The mounting number of inquiries from the trade—consumers and importers of essential raw materials of which the United States has an inadequate supply—prompted the publication of market analyses on tungsten, nickel, mercury, manganese, and antimony; and mica, certain grades of which are regularly imported to meet industrial demands, was discussed in International Trade in Mica. A revised edition of International Trade in Petroleum and Its Products, a world statistical compilation which is prepared annually

by the minerals division at the direct request of the trade, will appear early in 1930–31.

The preparation of a handbook on The World Coal Industry with Special Reference to International Trade in Coal was completed and it is now at the Government Printing Office. A series of articles on fuel and power facilities in Latin America was prepared for Commerce Reports. At the request of the trades involved the following mimeographed circulars are now released regularly:

Chinese Shipments of Antimony to the United States, issued monthly, based on data received by cable from China.

Special Cement Bulletin, a monthly statistical tabulation of United States imports and exports of Portland cement, with current information covering foreign markets and industrial activity in producing countries.

International Coal Trade Situation, a monthly résumé of foreign market news.

Foreign Petroleum Statistics, a monthly tabulation of production and trade statistics of foreign countries.

World Retail Gasoline and Kerosene Prices, a quarterly tabulation of current quotations throughout the world.

MOTION-PICTURE DIVISION

The motion-picture section was raised to the status of a division on July 1, 1929. This change was entirely administrative and involved no essential change in the scope or method of its work, which as in the year previous called for much readjustment to the changed conditions brought about by the production and exhibition of sound films. This development is now stabilized; but further scientific discoveries involving the more effective application of color in film production, the use of wide film, and the public experiments on television are beginning to cause further readjustments nearly as great and will continue to do so for some time to come.

Requests made upon the division continue to mount, being in 1929–30 some 25 per cent more than in the preceding year. These represented a wider range of services than ever before, including the furnishing of much foreign market data to companies manufacturing recording and reproducing apparatus and pertinent information as to the type of foreign-language version of talking pictures required in different markets abroad.

The motion-picture equipment section extended its field of contacts and contributed a number of publications to that branch of the industry, including a survey of prospects for equipment sales in the Far East. The assistant chief of the division, who is in charge of this section, took a prominent part in organizing the Convention of the Society of Motion Picture Engineers held in Washington last May, and his services in the cause of better film projection were publicly recognized by the Projection Advisory Council.

The industrial and educational work of the division is centered in a nontheatrical section. This section greatly increased its work and is rapidly becoming a standard authority on sources and distribution outlets for films of this type. Its Composite List of Nontheatrical Film Sources has been revised and extended, and considerable information has been put out in pamphlet form based on the

replies to a questionnaire sent to schools last year. An advisory committee of 10 members has been created in this branch of the trade, and with its cooperation a questionnaire is being prepared through which it is proposed to procure data on business films.

The motion-picture trade commissioner again performed work of outstanding value, not only by the submittal of over 200 market and statistical reports, but also by aid rendered branch managers of American film companies in Europe. Difficult legislative situations in certain continental countries were made the basis of a special advisory and reporting service. In September, 1929, the commissioner visited the United States and in company with the chief of the motion-picture division held numerous conferences in New York and Hollywood with members of the industry, during the course of which he outlined the changed conditions in Europe brought about by the sound film.

The foreign offices of the bureau were especially zealous in advising on new film regulations in effect or contemplated in their territories. Their aid was particularly valuable in securing, among others, a $150,000 Spanish contract for an American manufacturer of sound apparatus, and clearance for $300,000 worth of sound equipment of an American company which had been denied import permits in a country of Europe.

The volume of general published material of the division compared favorably with that of previous years. Information on Europe was brought up to date with the issuance of the European Motion Picture Industry in 1929, and a series of bulletins covered the Latin American field. There were, besides, 54 foreign market bulletins on particular phases of the film industry, and numerous special articles were contributed to the trade press. The division's weekly press service now embraces 102 newspapers and magazines, and distribution of the periodical release covering nontheatrical films is rapidly expanding.

Special services rendered during the year included aid in the revision of the foreign section of the Film Year Book; a survey of the more remote markets of the world where silent films still command major distribution; close cooperation with the Bureau of the Census in preparing the biennial questionnaire on film production; advice in the organization of the export department of a film distributor; and similar aid to a distributor of sound-reproducing apparatus.

PAPER DIVISION

Continued expansion in the output of nearly all grades of paper marked 1929–30. Our exports of paper products increased in total value during the first half of the year, but declined slightly in the second half. In the newsprint field an international group that includes producers in the United States has concerned itself with production and markets in an effort to stabilize conditions.

The industry here was actively assisted by the paper division in finding outlets for its products abroad, the largest individual number of inquiries probably relating to wall and insulating boards. Matters connected with domestic marketing also received much attention.

Division cooperation with manufacturers and exporters has been actively maintained through the trade associations in the paper in-

dustry, and close contact has been established with one of the associations devoted to the interests of the printing trades. Several manufacturers of printing equipment and supplies were aided in marketing their products and selecting representatives abroad. Mergers took place among makers of printing and lithographing inks, and the export offices of these new organizations were given assistance in their foreign-trade problems.

Articles of current interest appeared at regular intervals in Commerce Reports and at the same time the division's weekly news release was approximately doubled in size. A bulletin on the paper trade and industry of Japan was published, and one on Australia and New Zealand partly completed. Additional bulletins covering portions of Europe and the Near East are to be prepared for issuance during the current year, and a new series discussing world markets for specific items is to be begun. Preparation of a glossary of paper export terms in several languages also is to be started in cooperation with the bureau's foreign offices early in 1930–31.

A small increase in the personnel of the division will, it is hoped, permit a number of other new projects to be undertaken in collaboration with the various foreign and district offices of the bureau and with the trade associations interested.

RUBBER DIVISION

The high records of the rubber industry established in 1928–29 were followed in 1929–30 by general decreases. Crude-rubber consumption declined 15 per cent; tire production was less by 23,000,000 casings, or 27 per cent, and sales were 15,000,000 casings, or 19 per cent, lower. Tire manufacturers' inventories, however, were smaller at the end of June, 1930, by about 3,500,000 than on June 30, 1929, and replacement sales did not suffer the same severe decline registered in original-equipment sales. The other branches of the rubber-manufacturing industry were affected similarly, but not to the same extent, curtailed production of motor vehicles having practically no influence on these lines. Remedial action by the rubber industry during the past year included (*a*) mergers of small producers into large units, (*b*) plant economy and the discontinuance of inefficient plants, (*c*) diversification of production and the manufacture of articles required by established customers, and (*d*) better and more efficient methods of distribution, with the entrance of large manufacturers into the rôle of retailer.

The rubber division continued its various statistical-information services to exporters, manufacturers, crude-rubber importers and dealers, and rubber reclaimers. These services comprise statistics and special studies covering the international trade in rubber products; crude-rubber shipments, absorption, and stock statistics; and regular periodic surveys in behalf of manufacturers, embracing consumption and stocks of crude and reclaimed rubber and retail tire and rubber footwear stocks at the beginning and end of the usual purchasing season. The crude-rubber statistical services, particularly, were well received.

One of the helpful accomplishments of the division last year was the securing of a 33⅓ per cent reduction in ocean freight rates for rubber Wellington boots from the United States to Great Britain, thus enabling American exporters to compete on equal terms with

continental manufacturers for the British trade in this important item. The saving in freight should amount to approximately $50,000 annually.

During the year the division issued a trade information bulletin entitled "South American Markets for Rubber Sundries and Specialties" and a 7-part monograph entitled "Foreign Markets for Rubber Boots and Shoes and Rubber Heels and Soles," besides weekly circulars and news letters on world movement of and developments in crude rubber and weekly and monthly circulars covering foreign markets for all classes of rubber manufactures. Mimeographed material consisted of 377 circulars, 126 statistical statements, and 43 corrections to the division's loose-leaf manual of foreign import duties on rubber manufactures.

SHOE AND LEATHER MANUFACTURES DIVISION

While the work of the shoe and leather manufactures division, in the main, followed established lines last year, the increase in the number of firms listed on the Exporters' Index and the eagerness with which the division's advice is sought when foreign problems arise clearly indicate the trade's recognition of the service the bureau is rendering. The division has always stressed direct-sales service to the manufacturer and exporter through specific sales leads, aid in planning foreign sales campaigns, and the extension of existing markets for American leather manufactures. This has resulted in much good—and much new business—to the shoe and allied industries.

One of the outstanding achievements of the year was the organization in New England and in Brooklyn of export committees of shoe manufacturers. These groups, advised by the chief of the division, will work for the promotion of the shoe export trade. Another encouraging development of the year was the larger number of inquiries relative to foreign markets for shoemakers' supplies, such as findings and polishes, and for miscellaneous leather goods. A careful study of potential outlets for wares of this kind caused many more manufacturers than heretofore to take advantage of the bureau's foreign trade opportunity service.

With the cooperation of the bureau's field staff and consular officers of the Department of State, the division carried out special surveys covering boots and shoes, trunks, bags and suitcases, harness and saddlery, and miscellaneous leather goods in other countries. The data thus collected were published in Commerce Reports, in foreign market bulletins, and as special circulars.

The arrangement made by the division with the National Boot and Shoe Manufacturers' Association and the New England Shoe and Leather Association to mimeograph information compiled by the division and distribute it to the industry, without expense to the bureau, has proved exceedingly helpful.

SPECIALTIES DIVISION

American specialties set a new high figure in exports for the last calendar year, reaching a total of $200,500,000, or $17,500,000 above 1928, indicating the growing importance of this group of unrelated

items in the overseas trade of our country. Although the first half of the calendar year 1930 showed a certain falling off from the peak levels of 1929, some gains were made, and the total for the fiscal year was not unsatisfactory in comparison with other classes of exports.

In addition to the more important lines, such as business equipment, glass, sporting goods, toys, musical instruments, books, and scientific instruments, there figured in this trade bottle caps, calendars, playing cards, cigarette holders, soda fountains, shaving brushes, handcuffs, posters, vacuum bottles, post cards, and many other products. It is particularly noteworthy that a high ratio of exports to production is maintained in some of the specialty industries, notably office appliances, dental goods, musical instruments, and photographic materials.

As in other years, the division actively assisted manufacturers entering the export field in feeling out the possibilities for the sale of their merchandise and in finding new outlets for goods already established in world markets, and requests for help of this kind increased. There was a large demand, too, for the general trade-information service maintained by the division, for foreign-agency service, and for information on foreign advertising media and methods from American manufacturers, exporters, and advertising agencies. The trade-opportunity work of the division was improved by sending special supplementary notices to manufacturers as a means of getting the requirements of foreign buyers filled in a satisfactory manner without undue delay. A results file maintained in connection with this service shows that orders were placed ranging from $100 to $30,000.

Work was started on a digest and analysis of the trade information which has been received within the past few years on a wide variety of specialty articles. Trade data have been summarized commodity by commodity and incorporated in bound digests that are to be made available on a loan basis. It is planned to keep these digests up to date. Announcement of the completion of each one will appear in Commerce Reports.

The division assisted in several domestic-commerce surveys, including that of the blue-printing industry and of the jewelry industry, and regularly maintains statistics with respect to the domestic business trend in certain specialty lines.

Cooperation with the various specialty associations in the study of foreign and domestic trade problems was continued. At present the division is cooperating with the American Olympic Games Committee in securing from foreign countries lists of sporting and athletic associations that may participate in the 1932 Olympic events. This, with related information, will be highly useful to exporters of athletic and kindred goods. In certain lines, notably furniture, soda fountains, hotel equipment, and coin-operated machines, the division made particular effort to stimulate the interest of exporters, either because of opportunities which seemed to offer or because of the activity of European competitors. Results appear to be worth while, particularly in the case of coin-operated machines, where a number of initial orders are directly traceable to the division's labors and total exports are running nearly a third ahead of a year ago.

On account of the unrelated character of the many commodities covered, the specialties division has endeavored to develop closer contacts with manufacturers and to give to each one individual attention in the light of his own peculiar problems.

TEXTILE DIVISION

The world-wide depression which has faced the textile industry, particularly the cotton branch, for several years has caused competition in foreign markets to become unusually keen, with business going largely to the country of lowest production costs. Promoting the sale of American textiles abroad accordingly is fraught with more than ordinary difficulty. Although United States textile manufactures continue to be exported in substantial volume, foreign demand has been confined more and more to articles of recognized superiority in style, fit, quality, or durability. The textile division has intensified its efforts to find new export outlets for American textile products, but has met, in many cases, with increasing sales resistance. Trained specialists have been assigned to certain areas to promote the introduction of new lines and the sale of those already established there.

Through its close contact with the various domestic trade associations the division has been able, in many instances, to refer specific trade opportunities submitted by field officers of the Departments of Commerce and State to firms equipped to supply the articles desired and to insure thereby the satisfactory culmination of business. Furthermore, numerous samples were forwarded to the bureau's foreign offices for inspection by prospective buyers and agents in their territories. An effective supplement to these services has been the dissemination of pertinent information on current conditions and trends in textile producing and consuming countries through the medium of bulletins dealing with specific commodities, such as raw cotton, yarns, cotton piece goods, wool and wool manufactures, knit goods, silk and rayon, linens and laces, miscellaneous vegetable fibers, and wearing apparel. Developments of interest to laundry owners and dry cleaners also were covered in a bulletin issued by the division last year.

Substantial economies in Government textile purchases have been effected in recent years through standard commercial specifications devised by the technical committee on textiles of the Federal Specifications Board. The chief of the textile division is chairman of this committee. In compliance with instructions from the Chief Coordinator that all existing Federal specifications be revised, to secure greater uniformity and to insure maximum returns on Government expenditures for supplies, the textile committee completed the revision of about one-fourth of the outstanding textile specifications last year.

The division continued to collaborate with the Cotton Textile Institute (an organization of cotton manufacturers representing about 20,000,000 spindles) and the Department of Agriculture in the search for new and extended uses of cotton. Last year particular emphasis was laid on direct promotion of sales of cotton articles by stimulating consumer demand, and to this end four bulletins, The Automobile Trunk, The Athletic Field Tarpaulin, The Play Tent, and Speaking of Vacations, were issued. More than 200

articles of cotton, suitable for use in vacations throughout the year, are listed in the last-named pamphlet, of which approximately 425,000 copies were distributed to consumers through department stores and other retail outlets handling sporting and vacation supplies. This phase of the division's work has attracted favorable attention abroad. Cotton merchants and manufacturers in Great Britain are emulating the example thus set and attempting to increase the use of cotton goods through various publicity methods aimed to reach the ultimate consumer.

The United States Government was represented officially at the First International Fur Exposition held in Leipzig, Germany, last year. The division's fur section prepared data and charts showing the development of fur dressing and dyeing in the United States, fur manufacture, and foreign trade for the American exhibit. The textile division also cooperated with the Bureau of Fisheries of the Department of Commerce and the Biological Survey of the Department of Agriculture in the issuance of a 50-page illustrated booklet on the fur resources of the United States for use at Leipzig.

SPECIALIZED TECHNICAL SERVICES TO BUSINESS

COMMERCIAL INTELLIGENCE DIVISION

Development of the World Trade Directory of foreign buyers continues to be the most constructive work of the commercial intelligence division. The credit for building up this file of detailed reports on nearly 450,000 foreign firms belongs mainly to American consular officers, but the field men of the Department of Commerce also have contributed. During the past fiscal twelvemonth 31,299 reports were added to the file, exclusive of revisions; revised reports are being received constantly—last year 52,778 of them. It is of interest that during the same period 155,027 supplementary reports were received from American exporters, banks, and credit-reporting agencies on their individual experiences with foreign firms.

Because of the unique character of these World Trade Directory reports, it is apparent that they play an important part in the activities of American exporters in the expansion of their foreign sales. Last year 161,474 requests for these reports were received, and the demand continues to grow. About 60 per cent of the requests could be answered promptly out of the division's master file in Washington; the remaining 40 per cent required further information from the field. A heavy burden is placed on Foreign Service officers who must both gather facts for new reports and keep up to date the thousands of reports now on file; and ways and means should be found to expedite this work. This file has added interest when it is realized that it contains reports not only on foreign firms believed to be reliable, but also those regarded as unreliable.

The trade-list service, the oldest activity of the division, which charts foreign markets with respect to selling channels, now embraces 3,200 commodities and the names and addresses of 675,000 foreign importers, wholesalers, commission merchants, and large retailers, 185,000 foreign manufacturers, and 135,000 members of the professional class—physicians, surgeons, dentists, architects, and engineers. Last year 160 new lists were compiled and published and 648 were revised and reprinted. Seven hundred and forty-

one thousand of these lists were sent out upon specific request in 1929–30.

The foreign-trade opportunities coming to the bureau from consular and Commerce officers abroad are checked in the commercial intelligence division against its records prior to publication in Commerce Reports. Last year 9,013 were thus checked.

The service of suggesting suitable agents abroad has been much improved. Now, specialists in the division carefully select foreign agent distributors on whom a wealth of information has been developed with respect to sales experience and lines handled. While figures are not the best gauge, nevertheless the 3,922 inquiries that were given careful research and analysis last year attest the value of this activity.

The division is now prepared to supply current information with respect to credit conditions in other countries, particularly those areas where business is below normal; a digest based on cabled advices appears weekly in Commerce Reports. Three times monthly special reports are made to banks and credit-reporting agencies in the United States with respect to foreign firms in financial difficulties and those with which dealings are deemed hazardous or which resort to fraudulent and unethical practices. At all times the division is in position to furnish American exporters reliable and available sources of foreign credit information to aid in rating the foreign buyer as a credit risk.

A study of buying terms for basic commodities current in the trading centers of the world has been completed and is available to exporters generally. This is a virgin field of endeavor. A more intensive study is planned, and much of the material then gathered will later be published.

DIVISION OF COMMERCIAL LAWS

The past year's work of the division of commercial laws evidences the value of an informal medium through which cooperation may be extended toward the solution of such international legal problems as codification of laws, double taxation, protection of industrial and intellectual property, nationalistic trends in insurance and labor laws, and of those difficulties that arise in individual transactions in the foreign trade.

The Latin American legal section of the division continued its cooperation with the Comision Revisora del Codigo de Comercio de Chile. A new chattel-mortgage law was adopted by Chile based upon information placed before that commission, and other important revisions in consonance with advanced principles of American legislation are under consideration. Original studies were made concerning the liability of common carriers in 18 Latin American countries. Another original undertaking was checking for legal phraseology and content the first English translation of Las Siete Partidas (a thirteenth century compilation of Spanish laws which forms the groundwork of the various codes of every Spanish American country), to be published under the auspices of the American Bar Association; and cooperation was extended the Bar Association of the City of New York in the preparation of its second publication

on installment sales in Latin America. Encouraged by the fact that the bulletin on Trading Under the Laws of Argentina obtained a wider sale than any previous legal publication of the division, a similarly comprehensive study for Peru has been completed. Other publications of this section include special circulars on the laws of Brazil, Chile, Cuba, Mexico, and Peru.

Considerable increase in the work of the European legal section was occasioned by the contemplated or actual establishment of subsidiaries and branch factories in foreign countries, involving problems of incorporation and taxation. Numerous firms were informed regarding the legal requirements pertaining to doing business abroad, resulting in substantial savings to them in taxes, license fees, and royalty arrangements, and, among other matters, regarding foreign laws regulating the hiring and discharging of employees. Within the past year personal study of tax matters, with particular reference to double taxation, was made by a member of this section who visited the principal European countries. As a result of this research, material has been prepared for a bulletin dealing with the exceedingly complex subject of taxation of business in France. Similar information concerning German and Belgian systems of taxation was also obtained and is now being prepared for publication. Special circulars were issued on trading—particularly from the viewpoint of taxation and company law—in Austria, Belgium, Bulgaria, Great Britain, Hungary, Italy, Netherlands, and Spain.

The industrial property and copyright section has found such demand for information on protection against trade-mark piracy that a weekly Trade-Mark Application Service has been instituted. Despite continued publicity, through bureau publications and other media, many American manufacturers fail to protect their industrial-property rights in those civil-law countries which ordinarily grant such rights to the first applicant. Special studies were undertaken toward informing American owners of the working requirements of foreign countries affecting patents. In the field of copyrights, new questions have arisen by reason of radio broadcasting and talking-picture developments. Many other forms of unfair competition have come to the attention of this section; but, while all possible cooperation has been extended in individual cases, comprehensive study of the underlying problems has been delayed by lack of personnel. Material has been gathered for a monograph on Protection of Trade-Marks in Latin America, and special circulars have been issued relative to current trade-mark, patent, and copyright legislation in China, Ecuador, Guatemala, Mexico, Spain, Turkey, and Venezuela.

The work of the trade adjustment and insurance and labor laws section increased 56 per cent last year. As a trade barometer this increase, following one of 65 per cent the year before, indicates continuing economic depression in many foreign countries, causing "legally honest" purchasers to seek escape from contractual obligations. Through investigation and action upon complaints of foreign customers, American prestige and reputation for observance of proper trade practices has been maintained; through like attention to complaints against foreign firms, recoveries have been effected

for American exporters by payment, repossession of merchandise, or sale of stranded shipments. Many similar adjustments have been effected in matters handled directly by the bureau's foreign offices.

Lack of personnel precludes the functioning of the insurance and labor laws subdivision of this section as a separate unit although the nature of its work is in no way related to that of trade adjustments. Insurance developments within the past year were characterized by nationalistic enactments creating State monopolies, taxing premiums paid to other than national companies, and requiring such companies to maintain investments in the legislating country. In three known instances information furnished by the insurance and labor laws section enabled American insurance companies to make proper representations toward safeguarding their interests. Special study has been made of certain fields looking to the expansion of American insurance undertakings through the establishment of agencies or the purchase of existing companies. Among the section's publications of the year were bulletins on legal provisions governing the admission of American companies into foreign countries and employers' obligations under such forms of social insurance as workmen's compensation and industrial accident and incapacity benefits, including the very comprehensive French social-insurance law.

DIVISION OF CORRESPONDENCE AND DISTRIBUTION

Supervision of the incoming and outgoing correspondence of the bureau is centralized in the correspondence section of the division of correspondence and distribution. Besides the actual routing of incoming correspondence and the review of outgoing letters prepared by the commodity, technical, and regional experts of the bureau, the correspondence section is given oversight over the uniform and consistent treatment of similar problems by the different units at Washington and in the field, appropriate cooperation between the several divisions of the bureau in Washington and between the Washington organization and the field staffs, the efficient handling of correspondence, and like subjects.

During the year ended June 30, 1930, 214,630 letters were received in the correspondence section at Washington and routed to the appropriate units, and 245,444 outgoing letters were reviewed; besides which an outgoing correspondence comparing favorably in volume with that of many of the service divisions of the bureau was carried on in connection with the division's own work, letters and forms sent in answer to specific inquiries numbering nearly 15,000 last year. Progress has continued in the line of reduced letter writing through wider use of form letters.

The two main functions of the distribution section are (*a*) the elimination of duplication of material and (*b*) the distribution of the proper material to persons interested in the bureau's services. A large number of straight mailing lists come under the supervision of this section, but the main list, where duplication and proper distribution have to be constantly supervised, is the Exporters' Index—that highly classified list of 25,000 eligible American firms and individuals interested in foreign trade which forms the basis of the bureau's distribution of commercial information.

A new policy, that of making—with congressional approval—a nominal charge for the periodical mimeographed statistical statements distributed on some 350 separate mailing lists, has resulted in an elimination of wastage of material to contacts not really interested in the particular service. A considerable saving has also been effected through the distribution section's supplying the district offices of the bureau with addressed envelopes covering classified contacts in each territory as carried in the master files here in Washington.

EDITORIAL DIVISION

The intensifying of all the statistical and informational activities of the bureau last year meant a corresponding increase in the quantity of published matter; for, notwithstanding the many points of personal contact which the bureau has with the commercial community, in the main it must depend upon the printed word to carry to the public the information it has gathered.

The output of the editorial division in printed and mimeographed material during 1929–30, accordingly, was larger than for any previous fiscal period. Besides the regular publications—Commerce Reports, Commerce Yearbook, Statistical Abstract, Commerce and Navigation, and the Monthly Summary—135 special publications, ranging in size from 20 to 600 pages, were issued. Included among the latter were voluminous reports on the marketing and trade surveys conducted by the bureau in the domestic field; of this series, the Market Data Handbook of the United States has been declared one of the most important works in the domain of applied economics issued during the year.

The greater use of illustrations in bureau publications is meeting with a very favorable reaction, though further extension of the use of graphs, charts, and maps is checked by lack of personnel to prepare them.

FINANCE AND INVESTMENT DIVISION

Prospective underwriters of foreign bond issues, exporters contemplating sales to foreign governmental units, banks seeking foreign correspondents or desiring to deposit funds abroad, and concerns affected by bankruptcies of foreign financial institutions or by unstable foreign exchange sought the assistance of the finance and investment division in large numbers. Abnormal exchange conditions gave rise to numerous inquiries by exporters and others, as did also the unsatisfactory fiscal state of several areas, notably in Latin America. Fact finding on fiscal conditions abroad on behalf of the Department of State was an important new feature of the year's work. During the latter half of the year the chief of the division served as special financial adviser to the American ambassador at Habana.

In addition to its regular mimeographed releases and an unusual number of special articles in Commerce Reports, the division issued 13 trade information bulletins and also completed a handbook on American Underwriting of Foreign Securities covering the period 1914–1929. Among the more important of the bulletins were those on French Experience with Defaulted Foreign Bonds and The Price

of Silver; the latter was reprinted in the Congressional Record. The annual bulletin on America's balance of payments (a survey of the year's operations in dollar exchange) was still further improved by refinements in estimating the invisible items of our foreign trade.

Certain of the year's activities were offshoots of the balance-of-payments work. The division completed the manuscript of Promotion of Tourism in Foreign Countries; in April the Federal reserve banks began to accept Canadian bank notes from member banks without charges for collection—a practice proposed by the division in order to reduce the heavy discounts often charged on these bank notes and thereby to encourage Canadian visits to this country. Lastly, at the suggestion of the finance division the United States Bureau of Immigration began compiling more complete data on the departures of American citizens from seaports.

Early in the fiscal year the division began a census of American "direct investments" abroad; the results will be published shortly.

DIVISION OF FOREIGN TARIFFS

If the nature and volume of inquiries on subjects within the scope of the division of foreign tariffs received in the bureau and the various district offices from American firms in the course of the last year can be taken as an indication, there has been a substantially intensified interest in foreign-trade problems, at least in so far as the customs tariffs and trade regulations of foreign countries are involved. The major proportion of this growth has been in the inquiries answered by the district offices from the material prepared for them by the division in Washington. The number of inquiries handled in Washington does not show a corresponding growth, but the development may be seen in a change in the character of inquiry received. There has been a much larger proportion of that type of inquiry which submits an entire problem for consideration, or indicates in some other way a new or renewed interest in foreign markets and a hope of possibly overcoming certain barriers by a more complete understanding of their nature.

A rather distinct feature of many inquiries has been the question of possible tariff advantages to be gained by the building of branch factories in certain foreign countries, particularly Canada, to cover not only the local markets but also markets in certain other foreign countries. These inquiries have indicated a rather widespread misconception as to the tariff status of American goods abroad.

This prompted the issuance of a brief circular summarizing the tariff advantages and disadvantages of American products in competing for foreign markets. The wide demand for this circular in various sections of the country indicates the useful purpose it has served.

The customary activities of the division in aiding to prevent difficulties arising out of foreign tariff laws, customs and pure-food regulations, and the like and in salvaging as much as possible when such difficulties have been experienced have been continued. There has been the usual volume of requests for an explanation of the exact nature of foreign regulations which are not perfectly understood in their application to the exporter's specific articles or problems or on which he has received incomplete or inaccurate information. There

have also continued the usual requests for assistance in obtaining a more definite or perhaps a more favorable classification under the tariff of some foreign country; as well as complaints that for one reason or another difficulties have been experienced and fines or excess duties levied for infraction of some foreign requirements. In a number of cases it has been possible, with the aid of the American commercial attaché, trade commissioner, or consul stationed at the foreign port, to obtain a remission or refund of part or even the whole of such excess duties or fines.

There has been the customary cooperation with the Department of State in discussing the terms of commercial treaties under negotiation, and with other departments in regard to matters of common interest. There have also been during the year a number of international conferences of particular interest to the division of foreign tariffs, because of the nature of their subject matter, including the Pan American Conference on Customs Procedure and Port Formalities at Washington, held under the auspices of the Pan American Union; the conference at Paris, in December, 1929, with reference to the putting into effect of the International Convention for the Abolition of Import and Export Restrictions and Prohibitions, which had been ratified by the United States in September; and the conference for concerted economic action, more popularly known as the Conference for a Tariff Truce, held in Geneva under the auspices of the League of Nations in February and March, 1930, to which the United States was not a party, but the deliberations of which were necessarily of interest.

During the year the chief of the division visited Canada to study at first hand matters of Canadian tariff and customs procedure. There has been progress in the issuance of publications on which the staff of the division has been working, including Preparing Shipments to Canada which has received widespread distribution, and further numbers in the series of studies of foreign tariffs and regulations affecting agricultural products. There have already been issued in this series handbooks on Fresh Fruits and Vegetables and Canned Foods in Europe. Further numbers, including Canned Foods in the Western Hemisphere and one covering canned foods in Asia, Africa, and the Orient are ready for early publication.

A further development of the division's services which is worthy of mention has been the establishment of close contact with certain trade organizations having offices in Washington, with a view to the prompt dissemination through those organizations to the trade of news of current and prospective changes in foreign tariffs and trade regulations, more promptly and sometimes in greater detail than is ordinarily possible or convenient through the regular media of publication, such as the "Tariffs and trade regulations" column in Commerce Reports. This means of informal yet very effective cooperation has been especially developed with the local office of the National Automobile Chamber of Commerce, where it has been of substantial assistance in the prompt dissemination to the automotive trade of the news of changes or pending changes of interest to that industry. Similar cooperation is offered to any other trade organizations with which such local relations can conveniently be maintained.

DIVISION OF REGIONAL INFORMATION

Exporters, manufacturers, and bankers find it essential to observe continually foreign-market trends, the operations of our competitors in neutral markets, conditions affecting purchasing power, and the general effect on industry and trade of governmental measures, labor conditions, and numerous other factors. The division of regional information follows these trends, maintaining up-to-date files of information on general economic conditions and tendencies that may affect American business possibilities abroad. It frequently furnishes data that serve as a background to the more specialized information supplied by the commodity and technical divisions of the bureau.

The division has maintained mailing lists of organizations and individuals interested in specific regions, and to these it has sent the weekly Russian Economic Notes, Commercial Notes on Canada, China Monthly Trade Report, Japan Economic Letter, and circulars on miscellaneous subjects, including a complete revision of the circulars on cost of living for Americans in foreign countries. Publication in Commerce Reports of the weekly and monthly cables and radiograms continued, in addition to a great many special articles originating in the division or based on reports from the field officers of the bureau and the Department of State. At the end of the calendar year, extensive cables were published giving résumés of the economic position of leading foreign countries.

Once a month a survey of economic conditions in Europe was prepared especially for the use of the Bureau of Agricultural Economics, Department of Agriculture. Monthly cables were dispatched to the field offices of the bureau in the Far East for the special use of American chambers of commerce and American trade organizations in that part of the world. Through the National Automobile Chamber of Commerce, the automotive industry was furnished with a special cable service.

A publication of special significance completed during the year was the handbook on the United Kingdom. Work is progressing on a somewhat similar handbook covering France. Handbooks of this character have been found to be of great value to exporters already established abroad or perhaps without experience in the particular area treated. Work is now under way for a complete revision of the extensive Commercial Travelers' Guide to Latin America.

In collaboration with the division of statistical research, the Foreign Commerce Yearbook for 1929 was prepared, the division of regional information contributing the discussion of economic trends and outline of business conditions in the countries included.

The trade information bulletins embraced subjects such as Budgets of European Countries, Economic Review of Finland, Trends in Japan's Trade and Industry, Chain Store Developments in Great Britain, etc. In 1928–29 a publication entitled "United States Trade with Latin America for 1927" met with such popular appeal that a similar work covering 1928 was released this past year. A fifth edition of Employment for Americans in Latin America and a third edition of Employment in the Far East were published in answer to a steady demand for information of this character. Over 35,000 copies of these bulletins have thus far been distributed.

In accordance with a Senate resolution, a comprehensive report on American branch factories abroad and the significance of the subject to American industry is being prepared in cooperation with the finance and investment division, contributory information for this report being received from the field officers of the bureau and the Department of State. A preliminary article on the subject was prepared for Commerce Reports by the chief of the division of regional information.

Developments in the international cartel situation were closely followed by the division, an extensive library and file of data pertaining to this subject being maintained. At the start of the fiscal year the division chief attended the fifth general congress of the International Chamber of Commerce at Amsterdam and took advantage of this trip to Europe to make direct studies of European cartels and various economic problems associated with them. He had an opportunity of discussing these topics with leading European industrialists, foreign government officials, and United States Government representatives in European countries.

The chief of the Latin American section of the division visited five port cities during the year with a view to advising city authorities and business men on possibilities of developing Latin American trade, saving them heavy expense of individual investigation and possible expenditure of funds in the wrong direction. Section chiefs on the other areas were similarly called upon to address export meetings and trade organizations, and to discuss with individual business men the problems involving their particular regions.

DIVISION OF STATISTICAL RESEARCH

The division of statistical research was particularly active during the past year. Following the stock-market crash of October, 1929, there came to the bureau urgent requests for statistical information and analyses which would assist in judging business cycles and give that long view so needful for commercial restabilization. One of the publications of the division, the Commerce Yearbook, proved particularly useful in this emergency, and the demand for it quickly exhausted the entire 1929 edition of both Volume I, which surveys business conditions in the United States, and Volume II, which presents like data for about 65 foreign countries, and in the preparation of which the division of regional information collaborates. There was a steady call, too, for the Statistical Abstract, another regular annual publication of the division, designed more especially, however, for the careful student of economics who desires statistical material in much detail. The preparation of these three volumes is a major work of the division.

Analyses of the foreign trade of the United States by quarters and by calendar and fiscal years published in Commerce Reports or trade information bulletins made general information on our overseas movement of merchandise, and its significance, currently accessible; and in addition numerous analyses were made by the division, at the direct request of business men, regarding production, distribution, employment, and other phases of economic activity such as trend behavior of prices since 1920 and world potential

consumption or use of specific commodities or services, based on United States standards of living.

The Survey of Current Business, formerly published by the Bureau of the Census, was transferred to the division in June. The joining of the staffs and facilities of the Survey of Current Business with those of the statistical research division should make it possible to provide business men and economists with an unequaled statistical service.

Among the new publications of the year was a Handbook of Foreign Currency and Exchange, now in press, which will doubtless be found extremely useful as a ready-reference manual for bankers, economists, and business men.

Geographic services to exporters and technical and trade-promotion services to map publishers comprised the larger part of the geographic section's activities. Nearly 400 studies were made for exporters to supply them with data on climate, soil, or topography or a geographic analysis of a trade region. This information was utilized by them in planning their selling activities more effectively. For map publishers 32 important studies were made, besides many of smaller scope, and a special-circular service regularly supplies them with new material for their maps and atlases and with trade-promotion information. In the last-named activity the foreign service division is cooperating.

The translation section turned into English nearly 5,000 pages of text from 14 foreign languages and rendered into German, French, Spanish, Portuguese, and Italian 260 pages of English test. As in the past, specifications for public bids on private and governmental work in foreign countries were made available, through translation, to American manufacturers and exporters. Outstanding among the larger pieces of translating work were the new Mexican Labor Code, the French social insurance law, Lower Finow (Germany) canal lifting construction (new engineering technique), and the new Italian consumption tax law.

DIVISION OF STATISTICS

Collection of data relating to the foreign trade was one of the first statistical services undertaken by our Government. Year by year this service has been expanded and improved, until now the annual Foreign Commerce and Navigation of the United States and the monthly Summary of Foreign Commerce are indispensable in any study of our commercial position. Preparation of these two publications is a major activity of the division of statistics. Compilation of the master tables is done in the section of customs statistics at New York from export declarations and import entries forwarded to it from all customs ports in the country; elaboration of these tables and their preparation for publication are handled in the Washington offices. To make Foreign Commerce and Navigation even more useful to the business community it is proposed, beginning with the calendar year 1930, to enlarge the scope of the two principal tables therein (Nos. 3 and 4, giving exports and imports by articles and countries) by expanding them to cover a 5-year period instead of a single year as heretofore.

Other regular services of the division comprise some 250 mimeographed statements showing monthly movements of selected articles by countries or customs districts. Requests upon the division for general and specific information were 50 per cent heavier than in 1928–29.

A special publication of the division last year was a new Schedule A, giving the statistical classification and rates of duty for imports under the tariff act effective June 18, 1930. This new schedule, which was prepared in collaboration with the Tariff Commission, was distributed to collectors of customs on June 21.

For several years past the division has carried on a campaign of education having for its object perfection of the export statistics of the United States as to classification of commodities. Group totals are correct within narrow margins; but shippers have not infrequently called attention to discrepancies between their actual exports and the figures as published for specific articles. Inquiry disclosed that most of these variations were caused by incomplete descriptions or wrong quantities and values in export declarations, especially in those prepared by forwarding agents at seaports from railroad or steamship bills of lading. Furthermore, discrepancies have been noted in the published export figures for finished manufactures that were due to the minutely specialized subdivision of the statistical classifications which the industries themselves have asked for. Highly refined technical classifications can not always be differentiated by persons outside the particular industry, and statistical clerks at customhouses, not possessing specialized knowledge of the thousands of commodities described in export declarations, sometimes err in classification when the export document has not been carefully made out. To accomplish the accuracy that is both desirable and desired, it is essential—

1. That exporters who have exact knowledge of the goods prepare the export declarations in their own offices, instead of passing the task on to shipping agents at seaport or border points whose only source of information is the general description given in the bill of lading;
2. That the instructions in statistical export classification Schedule B as to countries of destination, quantities, values, and descriptions of articles be carefully observed and correctly entered in export declarations (Customs Form 7525); and
3. That the statistical class number of Schedule B be inserted by the exporter himself in the last column of the declaration, instead of leaving its insertion to statistical clerks at customhouses, who may, through lack of technical knowledge, insert a wrong class number.

TRANSPORTATION DIVISION

The past year was notable for the progress made in special research relating to transportation and communication. These two—transportation and communication—are elements vital to the conduct of every business; and the studies that are being carried out by the transportation division of the bureau are not only receiving recognition from organizations and individuals having a major interest in the particular subject under analysis, but they are proving of value to interlocking and subsidiary activities as well.

Research into what is practically a virgin field, that of traffic management in industry, was undertaken at the request and with the gen-

erous cooperation of the Associated Traffic Clubs of America, the regional advisory boards of the American Railway Association, and the National Industrial Traffic League. A handbook based on the data developed by this study will appear shortly under the title "Industrial Traffic Management: A Survey of Its Relation to Business."

The inland waterways section of the division published a Directory of Inland Waterway Lines of the United States, which met a long-felt want; and the section, cooperating with the domestic commerce division, made substantial progress in gathering basic material relative to the economics of inland-waterway transportation with special reference to operating costs, this survey necessitating considerable field work. Publication of the report thereon is scheduled for the current fiscal year.

The shipping section continued in Commerce Reports the semi-annual reviews of economic trends in the shipping industries of the maritime countries of the world. Special surveys of various aspects of the foreign shipbuilding industry were undertaken for the National Council of American Shipbuilders. This information has been valuable also to the Committee on Reducing the Differentials in Shipbuilding Costs Here and Abroad, which was appointed by the Second National Conference on the American Merchant Marine. The chief of the transportation division is a member of this committee and serves also on the Committee for Increasing Patronage of American Ships and the Committee for Aid to Cargo Vessels not Benefitted by Mail Contracts.

Three publications released by the division last year had reference to foreign ports; this research represents a joint work of the United States Shipping Board and the Bureau of Foreign and Domestic Commerce. Two of the completed reports related to the ports of Liverpool and Hamburg; the entire first edition of the remaining one, Foreign Bunkering Stations, has already been exhausted and its revision, for reissuance, is under way. Research regarding our foreign trade with Latin America through the ports of Argentina, Brazil, and Uruguay will supply the subject matter of monographs to appear during the current year.

Marked progress has been made in the study relative to Government aid to merchant shipping. The results of this research, comprising a complete historical review of subsidies and subventions by foreign governments to their ocean transportation lines, will be published soon.

The foreign railway section of the division continued to promote sales abroad of railway equipment—for the transportation division functions as a commodity as well as a technical unit of the bureau organization—placing numerous manufacturers in touch with foreign agents. It analyzed railway finances for American firms interested in bidding on construction projects in other countries. A comprehensive handbook on the railways of Chile was published as Part III of the Railways of South America series.

In its export-packing work the division continued to advise exporters regarding this important phase of exporting. During the year several plants were visited by division specialists and assistance furnished in designing satisfactory containers. Cooperation was

continued with the railways and express agencies in further reducing loss and damage claims through proper packing and stowage.

The division is cooperating with the Bureau of Public Roads of the Department of Agriculture in a motor-truck survey, based on information supplied by truck operators, that should prove of value in determining cost factors, radius of operation, and classes of commodities moving by this form of transportation.

The communications section rendered assistance to business interests and communications companies. In securing press rates and "collect" privileges on cable and radio traffic from all foreign offices of the bureau the section made possible greater economy in the expenditure of public funds for these purposes.

The chief of the transportation division is serving as a member of the subcommittee on ocean-mail contracts of the Interdepartmental Mail Contract Committee. As a result of ocean-mail contract requirements, shipbuilding in the United States has increased; it is estimated that approximately 10,000 men are employed in ship construction to-day, because of Government aid in the development of an American merchant marine, who would not otherwise have found such employment. Gross tonnage of merchant vessels of 100 tons or more building on July 1, 1927, totaled 219,000; on July 1, 1928, 264,000; on July 1, 1929, 170,000; and on July 1, 1930, 476,000 gross tons. A number of steamship companies have recently reported that, owing to their strengthened position through ocean-mail contracts, they have obtained more advantageous results from their ocean-steamship conference efforts. These "conferences" comprehend agreements covering freight and passenger rates, regulations, and practices for a stipulated period.

A publication of the division that has been particularly helpful to the ocean-mail contract subcommittee is Ocean Routes in the United States Foreign Trade, in the preparation of which the division of regional information of the bureau gave most valuable aid.

NEW RECORD SET IN DIFFICULT PERIOD

Year by year Congress has continued to show its confidence in the work which the bureau is doing in behalf of American commerce and industry by larger allotments of funds. Last year the 7 per cent increase in the bureau appropriation—the total being $4,906,323, against $4,603,357 for 1928–29—was matched by a 9 per cent increase in the number of services (3,631,558, against 3,342,118) rendered by bureau offices in the United States—for no numerical record is kept of the services of the foreign offices, although the funds to maintain them are included in the sums just named—and a 19 per cent gain in known new foreign business and savings ($50,545,242, against $42,651,854) for which the bureau was given credit by the reporting firm; to accomplish which there was an increase of less than 2 per cent in total personnel (1,446, against 1,426).

Allocation of bureau services by subjects covered makes plain the growing appreciation by the commercial community of what the bureau is striving to accomplish.

Class of service	Fiscal year ended June 30—				
	1926	1927	1928	1929	1930
Total services rendered [1]	1,973,524	2,421,563	2,770,773	3,342,118	[2] 3,631,558
Commodity:					
Aeronautics trade	([3])	([3])	([3])	([3])	43,937
Agricultural implements	29,753	53,444	73,463	89,591	88,641
Automotive	228,727	214,806	236,060	251,392	283,065
Chemical	119,613	122,300	126,007	146,122	170,581
Electrical equipment	133,462	109,947	117,788	142,526	157,420
Foodstuffs	155,301	180,867	226,445	247,092	252,371
Hides and leather	16,858	26,300	28,200	36,122	29,122
Industrial machinery	117,200	90,937	94,709	139,304	176,375
Iron, steel, hardware	221,252	213,949	216,975	236,550	264,318
Lumber	91,393	118,472	112,450	128,782	145,263
Minerals	28,172	54,503	80,026	92,258	84,587
Motion pictures	([4])	([4])	([4])	([4])	31,379
Paper	11,785	21,861	27,326	34,970	32,693
Rubber	14,260	21,790	23,893	31,660	27,185
Shoe and leather manufactures	7,148	12,744	14,740	21,492	23,325
Specialties	[5] 185,667	[5] 134,637	[5] 149,748	[5] 189,597	210,216
Textiles	106,590	124,332	129,139	166,855	185,863
Technical:					
Commercial intelligence [6]	([7])	([7])	([7])	119,582	160,245
Commercial laws	16,318	16,984	24,543	32,161	39,624
Finance and investment	20,578	27,743	37,304	43,732	46,341
Foreign tariffs	30,031	43,160	66,962	89,732	109,287
Statistical research	([7])	([7])	([7])	([7])	48,060
Statistics (foreign trade)	50,749	37,874	54,166	77,367	114,766
Transportation	[8] 25,806	[8] 36,506	[8] 55,956	[8] 76,160	58,649
Miscellaneous [9]	[10] 362,861	[10] 758,407	[10] 874,873	[10] 949,071	848,245
Foreign trade opportunities:					
Number published [11]	5,380	5,088	5,904	7,218	7,070
Number of cases in which reserved information was furnished [12]	437,059	578,343	713,805	885,213	915,058
Trade lists, [13] number of copies furnished on request	578,524	537,144	568,696	690,372	740,823
Special informational circulars (mimeographed), number of copies distributed	3,327,120	2,583,725	3,659,725	3,626,135	3,579,176

[1] Does not include services rendered by the foreign offices of the bureau nor by the cooperative offices maintained by the bureau in chambers of commerce and boards of trade in the United States.
[2] Included in this total are 441,719 services rendered in behalf of domestic commerce, contrasted with 265,375 for the preceding year.
[3] Included in "Transportation."
[4] Included in "Specialties."
[5] Includes "Motion pictures."
[6] Washington headquarters only.
[7] Included "Miscellaneous."
[8] Includes "Aeronautics trade."
[9] Services not identified under a specific group.
[10] Includes "Commercial intelligence" and "Statistical research."
[11] Foreign trade opportunities are specific openings for business in other countries notice of which is sent to Washington by the Foreign Services of the Departments of Commerce and State and published in the bureau's weekly publication, Commerce Reports.
[12] Confidential information relating to trade opportunities distributed only to persons and firms listed on the bureau's Exporters' Index.
[13] Lists of importers, wholesalers, commission merchants, large retailers, etc., in foreign countries.

In achieving the results shown in the above tabulation much help was received from other branches of the Government, for all of which the bureau makes grateful acknowledgment, but particularly for that accorded by consular officers of the Department of State. Steps were taken during the year to coordinate the commercial activities of the overseas representatives of the Departments of Commerce and State, and regulations were adopted which will prevent duplication of work and at the same time assure that every American firm which requires assistance abroad will receive the most efficient service from the combined facilities of the two departments.

Very truly yours,

WILLIAM L. COOPER, *Director.*

BUREAU OF STANDARDS

DEPARTMENT OF COMMERCE,
BUREAU OF STANDARDS,
Washington, July 1, 1930.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: I submit herewith a brief report upon the work of the Bureau of Standards during the fiscal year ended June 30, 1930. The various outstanding accomplishments are grouped according to the subjects for which the Congress had made specific appropriations.

GENERAL ACTIVITIES

Cooperation.—In addition to the several hundred governmental, scientific, technical, and industrial organizations which help to make the bureau's work effective, 38 industrial associations and individual firms take part in the bureau's research program directly through 97 research associates stationed in the various laboratories.

Personnel.—In September, 1929, R. M. Hudson, assistant director in charge of commercial standardization, resigned to accept the position of technical adviser to the New England Council with headquarters in Boston. As of July 1, 1930, J. S. Taylor will be promoted to chief of the division of building and housing. Mr. Taylor has been connected with this division since its establishment in 1921. and has served as its acting chief since 1928.

The regular staff at the close of the fiscal year numbered 1,055 employees. With miscellaneous assignments, the grand total was 1,161 persons, an increase of 89 as compared with last year. The turnover was 22.2 per cent. There were 645 promotions and reclassifications to higher grades, and the average salary, $2,450, increased by $37.

The contributions of members of the bureau's staff to scientific and technical progress have received public recognition in several cases. The degree of doctor of science was conferred on W. W. Coblentz by the Case School of Applied Science for his contributions in the field of radiometry, while the same degree was conferred by Stevens Institute of Technology upon N. S. Osborne in recognition of his research work on the physical properties of ammonia and steam. The director of the bureau was elected an honorary member of the Imperial Japanese Society of Mechanical Engineers on the occasion of the International Engineering Congress at Tokyo. E. C. Crittenden is serving as president of the United States National Committee of the International Commission on Illumination. A gold

medal was awarded to the Bureau of Standards for its part in the exhibit of the Department of Commerce at the Ibero-American Exposition held at Seville, Spain, in 1929.

Visiting committee.—The present personnel of the committee is: W. R. Whitney, John R. Freeman, Gano Dunn, S. W. Stratton, and Charles F. Kettering. The committee held one meeting at the bureau, advocating the establishment of a national hydraulic laboratory, the purchase of additional land, the making of desirable alterations to buildings, and preparing a patent policy.

Hydraulic laboratory.—An advisory committee on the design, scope, and problems of the National Hydraulic Laboratory, consisting of representatives of the interested Government departments and a number of prominent hydraulic engineers, has been appointed. Tentative designs are now receiving consideration. It is expected that the laboratory will be finished by July, 1931.

The new laboratory will have three principal functions: (1) It will carry out fundamental investigations on all types of hydraulic phenomena to increase the accuracy of flow coefficients and to extend our knowledge of these phenomena; (2) it will conduct model studies of proposed hydraulic structures to determine the form which is most effective and least expensive to build and maintain; (3) it will conduct routine tests on all kinds of hydraulic instruments, meters, and accessories, and develop and improve such equipment.

International relations.—The International Committee on Weights and Measures at its meeting in June, 1929, took definite steps toward putting electrical units on a new basis and decided also to take up the problem of the measurement of light. The action on electrical units followed exactly the recommendations made by the bureau to the International Advisory Committee on Electricity and approved by that committee. The effect will be to make the electrical units concordant with mechanical units as based on the fundamental centimeter-gram-second system.

A meeting of the Advisory Committee on Electricity was held June 23–25, 1930, in Paris. The bureau submitted recommendations on photometric units and methods, including a proposal that the complete radiator ("black body") at the freezing point of platinum be adopted as the primary standard of light.

Two members of the bureau's staff served as technical advisers to the American delegates at the first meeting of the International Technical Consulting Committee on Radio Communications held at The Hague in September, 1929. This committee, which is to meet at 2-year intervals, deals with scientific and engineering problems arising under the International Radiotelegraph Convention.

The first international steam-table conference held in London, July 8–12, 1929, and the second conference held in Berlin, June 23–27, 1930, at the time of the Second World Power Conference were attended by two representatives of the bureau. The first conference adopted a master steam table, with values and tolerances, which will serve as a gage to judge published tables for accuracy. Instead of the kilocalorie, as defined by the London conference, the bureau has suggested the use of the true joule and kilojoule as heat units, in conformity with existing laboratory practice.

For the Berlin conference a complete report of the bureau's work on heat content of saturated water and steam up to 270° C., and on latent heat of vaporization in the range 100° to 270° C., was available in printed form.

Three papers were presented at the World Power Conference at Berlin, June, 1930, entitled "Scientific Research in the United States on Gasoline Engines," "Volatile Liquid Fuels," and "Government Interest in the Advancement of Standardization."

Resistance thermometers have been intercompared at the National Physical Laboratory, the Physikalisch-Technische Reichsanstalt, and the Bureau of Standards, in connection with work on the international temperature scale.

Values obtained at four laboratories (National Physical Laboratory, Physikalisch-Technische Reichsanstalt, Nela Research Laboratory, and Bureau of Standards) for the melting point of palladium have been found to lie within a range of 4° C., thus justifying the adoption of 1,555° C. for the international temperature scale.

Standard cells have been exchanged with the national laboratories of Great Britain, Japan, and the Union of Socialist Soviet Republics.

A source of error in a mica condenser measured at the National Physical Laboratory and the Bureau of Standards was traced to damage received in transit, the actual capacitance measurements of the two laboratories being in good agreement.

The director of the bureau attended the World Engineering Congress held at Tokyo, Japan, in November, 1929, and presented a paper on precision machines and instruments for the measurement of length. In addition to presenting the paper and presiding over several sessions of the congress he served as one of the official delegates of the National Screw Thread Commission and eight other national bodies.

Visitors.—The bureau has been honored by many distinguished visitors from all over the world, among whom may be mentioned Profs. Masao Kamo and S. Jimbo and Dr. Seizo Saito, of Japan; Profs. Heinrich Barkhausen, Beno Gutenberg, Ludwig Prandtl, T. H. von Karman, D. F. Körber, and E. H. Schulz, and Dr. Karl Maybach, of Germany; Prof. Ernst F. Petritsch, of Austria; Dr. M. Chatelain, head of the Central Bureau of Weights and Measures; Dr. Richard Vieweg and Prof. E. A. Chudakov, of the Union of Socialist Soviet Republics; Drs. Tranquillo Zervi and Umberto Savoja, of Italy; Dr. Bengt Kjerman, of Sweden; Mr. Bernard Brull, of France; Prof. Robert K. Murphy, of Australia; Prof. H. Bolognini, of Argentina; Prof. P. H. Hermann, of Holland; and Prof. W. Baldwin Fletcher, of England.

In addition to these individuals, the officers and graduating students of the Japanese Naval Academy, the Japanese Lighting Mission, the American Society of Mechanical Engineers (in connection with their fiftieth anniversary celebration), a special delegation of professors and students from the University of Delft, Holland, the Society of Motion Picture Engineers, a delegation of Swiss electrical engineers and metallurgists, and many other groups have visited the bureau's laboratories. The records show visitors from such distant places as Calcutta; Formosa; Harbin; and Tashkent, Turkestan, besides practically every country in Europe and America.

Weights and measures conference.—The twenty-third meeting of the National Conference on Weights and Measures was held under the auspices of the bureau on June 3 to 6, 1930. Two important additions were made to the general specifications for weighing scales; antifriction elements must be used where necessary and provision made for adjusting the balance condition of scales. Minor changes were made in the codes for liquid-measuring devices and lubricating-oil bottles. A complete code for odometers was adopted in tentative form and will come up for review and final action next year. One amendment to the code for grease-measuring devices was adopted.

A beginning was made in the development of a code of specifications for automatic-indicating scales, and it is anticipated that this subject will be given consideration at several future meetings.

By resolution, the conference condemned the use of small-diameter, tall bottles with integral spouts and no vent for dispensing lubricating oil, and approved the use of a chemical treatment to reduce the dust from coal, provided the treatment does not increase the weight per ton by more than 30 pounds, and provided such coal is advertised as "chemically treated" coal.

Technical papers on many weights and measures subjects were presented, and a special demonstration of gasoline-metering devices was given for the benefit of the delegates.

Conference of State utility commission engineers.—The eighth annual conference of State utility commission engineers was held at the bureau on June 5 and 6. Committee reports were presented on rural electrification standards, depreciation and obsolescence, rate decisions, uniform types of rates, and charges for fire protection. The technical papers covered radio interference; submetering; trends in high-tension transmission practice; investigation of complaints by commissions; definitions in connection with utility appraisals; distribution extension rules applicable to electricity, gas, and water: improvements in rural telephone service; trends in urban transportation; future of electric railways; and a discussion of a questionnaire on gas-service standards.

Conference on street and highway safety.—The bureau took an active part in the national conference on street and highway safety called by the Secretary of Commerce, and submitted several recommendations for traffic control.

Federal Fire Council.—This organization was formed at a conference of Government representatives called by the Secretary of Commerce on April 3, 1930, to function in advisory and informative capacity on matters relating to fire prevention and protection arising in connection with Government activities. While the period has been required largely for organization and preparatory detail, several requests for assistance from departments and establishments have received attention.

American Standards Association.—The bureau has continued its close cooperation with this association. The bureau is sponsor for 81 standardization projects and is represented on 14 committees having for their object the formulation of American standards.

National Screw Thread Commission.—The activities of the commission have been directed principally along lines calculated to bring its screw-thread standards into wider and more effective use. The latest report of the commission (Bureau of Standards Miscellaneous Publication No. 89) has been subdivided into three sections and republished as separate pamphlets covering: I. Standard Threads; II. Special Threads; and III. Plain and Thread Plug and Ring Gage Blanks. These are intended primarily for shop use. They have also been submitted to industry, through the division of trade standards for acceptance as commercial standards.

American Gage Design Committee.—The report of this committee (Bureau of Standards Miscellaneous Publication No. 100) has met with wide acceptance and approval by manufacturers and users of limit gages. Its wide use has resulted in substantial savings in industry.

Federal Specifications Board.—This board, of which the Director of the Bureau of Standards is ex officio chairman, has promulgated its six hundred and fifty-first purchase specification. A large part of the research and experimental work on which these specifications are based is performed in the bureau's laboratories, and the chairmanships of many of the board's committees are held by members of the bureau's staff.

Relations to Government departments.—The bureau is authorized to receive funds for specific research projects from other departments, and in pursuance of this policy in the past year the bureau has received $436,387 for the support of 37 projects representing work for 10 Government establishments. In addition, the usual consulting, specification, and testing work has been carried on for almost every branch of the Government.

Publicity, bureau reports.—The number of research papers published in the Bureau of Standards Journal of Research was 106. Including articles in the Journal, and all other papers in the regular series of the bureau, the total number of publications released during the year was 182. About 240 papers were published in outside journals. The Technical News Bulletin and the newly established Commercial Standards Monthly have been issued each month. The latter has attained a paid circulation of over 5,000. There have been released to the press 218 short accounts of interesting achievements. The fourth annual number of the Standards Yearbook was published in March.

Testing.—Table 1 gives a summary of the bureau's test work for the past year. The total number of tests completed was 200,726, and the fee value $683,614.51. The corresponding figures for 1929 are 173,512 and $544,402.33. In 1928 the tests numbered 132,213 with a fee value of $465,116.82.

TABLE 1.—*Numbers of test items, determinations, and fee value for tests completed during the fiscal year ended June 30, 1930*

Kind of instrument or material, class of test, or nature of service rendered	Number of test items for—			Total number of test items	Number of determinations	Fee value
	Public	Government departments and State institutions	Bureau of Standards			
Electrical standards, instruments, and materials	784	635	368	1,787	2,762	$15,955.25
Electric batteries	-------	4,210	4	4,214	8,990	24,679.00
Electric lamps and lighting equipment	286	3,649	508	4,443	4,536	[1] 24,913.02
Length-measuring devices	131	142	4	277	2,093	2,712.25
Gages and gage steels	2,061	440	213	2,714	11,518	2,557.35
Haemacytometers, sieves, thermal expansion, etc	3,382	1,660	127	5,169	18,577	11,443.35
Weights and balances	4,969	1,768	1,132	7,869	17,643	7,333.60
Scales	28	1,069	-------	1,097	30,558	49,461.50
Timepieces	259	33	48	340	4,013	768.50
Volumetric apparatus	9,746	4,938	471	15,155	31,197	11,258.45
Hydrometers	522	571	38	1,131	2,661	1,359.50
Density determinations, etc	-------	10	467	477	562	774.00
Laboratory thermometers	2,719	1,105	695	4,519	18,960	10,020.30
Clinical thermometers	27,271	73,377	-------	100,648	402,512	13,424.70
Pyrometers, calorimeters, etc	176	50	82	308	4,126	3,844.50
Insulating materials	52	23	16	91	69	765.00
Fire-resisting materials	9	55	4	68	174	7,136.00
Fuels and lubricants	246	1,388	209	1,843	9,966	16,636.00
Automotive equipment, etc	10	119	47	176	410	4,157.00
Airplane engines	-------	46	-------	46	337	67,785.00
Optical instruments and materials	603	272	153	1,028	2,862	6,121.70
Carbohydrates	20	1,589	-------	1,609	2,508	2,803.00
Radioactive materials	1,228	11	1	1,240	1,191	5,567.00
Engineering instruments and appliances	118	987	30	1,135	1,288	17,292.00
Aeronautic instruments	50	686	16	752	3,540	10,225.50
Aerodynamic tests of models	22	-------	-------	22	32	175.00
Physical properties of engineering materials	130	2,944	46	3,120	6,345	14,964.60
Sound producing and measuring instruments	15	25	1	41	52	815.00
Making of special castings	-------	27	147	174	887	2,310.68
Fusible boiler plugs	-------	301	-------	301	602	752.50
Metallographic examinations	-------	770	198	968	3,710	5,544.09
Miscellaneous metallurgical tests	-------	269	347	616	7,059	7,143.75
Pottery and china ware	-------	77	-------	77	330	632.50
Glass	-------	86	20	106	208	437.00
Refractories and heavy clay products	-------	306	56	362	1,334	3,372.00
Cement, concreting materials, lime, etc	35	11,959	76	12,070	56,430	[2] 156,032.00
Stone and sand-lime brick	-------	109	44	153	611	2,096.00
Miscellaneous ceramic materials	16	2,095	200	2,311	7,957	15,982.00
Rubber	1	1,425	3	1,429	10,613	25,423.50
Textiles	23	6,105	805	6,933	15,848	31,078.25
Paper	12	1,427	346	1,785	5,689	15,851.00
Leather	136	602	-------	738	2,540	3,870.00
Paint, varnish, and bituminous materials	2	1,974	33	2,009	15,937	42,585.92
Chemical analysis of metals	16	372	187	575	2,361	7,019.75
Chemical tests of miscellaneous materials	19	1,162	27	1,208	4,287	11,771.50
Distribution of standard samples	7,251	336	5	7,592	79	16,764.00
Total	62,348	131,204	7,174	200,726	[3] 725,964	[3] 683,614.51

[1] Includes fee value of $5,480.02 for inspecting 2,005,406 incandescent lamps at various factories for other branches of the Government.

[2] Includes fee value of $47,049 for sampling, testing, and shipping 3,315,116 barrels of Portland cement and 50,200 barrels of masonry cement.

[3] Of these totals 195,124 determinations were for the public, fee value $72,251.45; 510,507 determinations were for the Government departments and State institutions, fee value $567,771.27; 20,333 determinations were for the bureau, fee value $43,591.79. The number of test items, and determinations necessary in connection with the bureau's own work of research and standardization, with the resulting fee values, is not included in these totals.

SALARIES ($686,146)

This fund provides for personal services of administration and operation; the establishment, upkeep, and comparison of standards; the development of methods of test, as well as most of the testing; and for the determination of fundamental constants of

importance in physics, chemistry, engineering, and technology not otherwise provided for.

Standard wave lengths.—As possibly more suitable as a fundamental unit of length than the wave length of the red radiation from cadmium, the wave lengths of the stronger lines of krypton and of xenon have been compared with neon standards by interferometer methods; the average deviation of an observed wave number from the calculated value is less than 1 part in 20,000,000.

Special material for line standards.—The steel mentioned in the annual report for 1929 proved to be unsatisfactory because of inclusions, flaws, and excessive thermal expansion. A systematic search of stainless steels finally located in a 14 per cent chromium and one-half per cent carbon steel a material which appears to be satisfactory from the five standpoints of polish, homogeneity, hardness, thermal expansion (practically same as platinum), and resistance to corrosion.

Comparisons of length standards.—The work of intercomparing the bureau's meter bars has been continued, special attention being given to the decimeter intervals of the subdivided meter bars and to a group of 7 decimeter bars, 3 of which belong to the bureau and 4 to cooperating universities. All 7 of these bars were from the same original series issued by the International Bureau of Weights and Measures.

The intercomparison of the bureau's platinum-iridium meters having been completed, the following relations have been determined and will be regarded as official until such time as new certificates may be issued by the International Bureau of Weights and Measures:

$$M\ 27 = 1\ m - 1.40\ \mu + (8.620 + 0.00177\ T) \times 10^{-6} T.$$

as reported by the International Bureau,

$$M\ 21 - M\ 27 = +5.07\ \mu \text{ at } 23^\circ \text{ C.}$$
$$M\ 12 - M\ 27 = +4.49\ \mu \text{ at } 23^\circ \text{ C.}$$
$$M\ 4 - M\ 27 = -4.29\ \mu \text{ at } 23^\circ \text{ C.}$$

as determined at the Bureau of Standards.

Many comparisons of high precision were also made on 4-inch scales and 1-decimeter scales ruled by the interferometric methods.

Graduation and calibration of circles.—Three 9-inch circles for first-order Coast and Geodetic Survey theodolites and six 6½-inch circles for second-order theodolites were graduated.

Methods of length measurement.—The high precision now being obtained with the bureau's longitudinal comparator made advisable an investigation of computational methods proposed for the determination of corrections to the subintervals of a graduated line standard.

Defects inherent in Guillaume's abbreviated method, which has been used at the bureau for several years, have been pointed out by various writers. The computational methods of Dziobek and Leman are being studied, and although the work is not yet completed, it appears that the average variation of the results of Guillaume's simplified computation from these two results is about 0.02 micron.

Improvement in accuracy of end standards.—A set of 11 standards submitted by a manufacturer, ranging by steps of millionths of an inch from a nominal length of 0.100000 to 0.100010 inch, were tested and all found correct within a maximum error of three ten-millionths of an inch in planeness and parallelism of ends, and in length.

Weights and measures testing.—Many yard and meter bars, steel tapes, base-line tapes, level rods, sieves, haemacytometers, and other standards, instruments, and devices of this character have been tested. The longitudinal comparator has enabled the bureau to make comparisons and calibrations of length standards with high precision and remarkable rapidity.

Seconds signals from a pendulum by use of a photo-electric cell.—Seconds signals from the pendulum of the bureau's Riefler clock, by the use of a photo-electric cell, have been in successful use in three of the laboratories. A new precision clock designed by the chief of the time section, and especially adapted to use with the photo-electric cell, is now being constructed.

Cooperation with Horological Institute of America.—Repaired watches, submitted to the institute by individuals as a part of an examination for certification as qualified watch-repair men, have been tested, as heretofore.

Specifications for stop watches.—Assistance has been rendered in preparing Federal specifications for stop watches.

Glass volumetric apparatus and hydrometers.—The quality of volumetric apparatus submitted for test has remained high, 98 per cent of that submitted having been found qualified for test, and 94 per cent of that tested having passed the test for accuracy of graduation.

Density of aqua ammonia.—The necessary material and apparatus for determining the density and thermal expansion of anhydrous ammonia and of various percentages of aqua ammonia have been obtained and the work will be undertaken in the near future.

Density of chromic-acid solutions.—Density determinations have been made on several samples of chromic acid.

Orifice meter tests.—A group of tests were made in Los Angeles, Calif., on orifices in 16, 8, and 4 inch lines, particular attention being given to large-diameter ratios and high-discharge velocities. The results are very consistent and give additional information on the effect of the expansion factor upon the discharge coefficient.

Chromium plating, platinum plating, and nichrome for weights.—Chromium-plated weights given a service test behaved about the same as other electroplated weights of the same type. Old analytical weights plated with platinum have not been found constant, most of them showing a gain. In order to obtain data on the usefulness of nichrome for weights preliminary plans have been made for investigating this material.

Lacquer for weights.—Additional tests of insulating lacquers have not developed any which are radically different from those previously investigated. Tests on weights 23 years old show that age has no tendency to change the behavior of shellac lacquer.

Improvement in constancy of weights.—The investigation on variability of weights with changes in the humidity of the air has reduced the percentage of variable weights on the market and has

definitely prevented many laboratories from receiving seriously variable weights that would otherwise have been sold to them.

Maintenance of standard weights.—About 200 of the standard weights of the mass section of the bureau were recalibrated. This is nearly five times as many as were recalibrated during the preceding year.

Equipment for testing weights.—A new high-precision 200-g balance constitutes a valuable addition to the equipment of the section. A high-grade new balance of 50-pound capacity has also been placed in use.

Ratios of international electrical units to absolute units.—A considerable number of measurements have been made with the reconstructed Rosa-Dorsey-Miller current balance to determine the value of the international ampere in absolute units, but no final value has been reached. Another type of apparatus for the absolute measurement of current, known as the Pellat current balance, has been designed and partially constructed.

Measurements of inductance preliminary to determining the value of the ohm have been nearly completed on a solenoid wound on a porcelain cylinder, and two additional solenoids have been constructed, one on a pyrex-glass form, the other on a fused-quartz form. These latter solenoids have been made with extreme care and every precaution is being taken in the measurements, with the expectation that the final result will be accurate within 1 part in 100,000.

Standards of electromotive force.—Improvements have been made in the standard cell equipment including the design and construction of a new laboratory room especially adapted to the purpose. Additional space has been provided for the increased amount of testing now required, refrigeration is available for holding the temperature of the baths to a constant value in summer, and a new and better oil bath has been constructed for the cells which constitute the primary standard. In moving the primary-standard group from its old location no perceptible change in its value has been introduced, check measurements in the old and new locations agreeing on the average to within four ten-millionths of a volt. Several comparisons have been made with the national laboratories of England, Germany, and Japan. Complete data are not available in all cases, but the results indicate the same relative standing of the units as before.

Intercomparison of resistance standards.—Three resistance standards of the new type developed by the bureau were measured at the British and German national laboratories. The results indicate that the unit of electrical resistance as maintained by the three laboratories is in agreement within two or three parts in a hundred thousand.

Magnetic testing and research.—An investigation on the standardization of magnetic permeameters was completed. Work was also done on testing with intense fields and on testing with alternating currents at low inductions. In the field of magnetic analysis, experiments were carried out on the relation between magnetic properties and impact strength, and a study of the phenomena associated with the tempering of heat-treated bridge wire was started, using the methods of thermomagnetic analysis.

Standards of candlepower.—Four blue glass photometric filters that had already been measured at the Physikalisch-Technische Reichsanstalt and the National Physical Laboratory were measured by three independent methods, and complete reports were submitted to the cooperating laboratories in England, France, and Germany. The glasses have been forwarded to France for measurement at the Laboratoire Central d'Electricité. Carbon-filament standard lamps have also been sent to the national laboratories of England, France, Germany, Union of Socialist Soviet Republics, and Japan for international check measurements.

Waidner-Burgess standard of light.—The experimental work in connection with the setting up of this standard has been completed, the technique and procedure having been refined to a point where the operation is mere routine. A thorough study has shown that the standard is reproducible, practical, convenient to operate, and inexpensive. The final result obtained is that an opening 1 square centimeter in area in a black body at the freezing point of platinum emits light equivalent to 58.84 international candles.

Constant of gravitation.—This project has been completed and will be given publication in the bureau's Journal of Research within a short time. The mean result obtained is 6.6670×10^{-8} in c. g. s. units.

Absolute determination of gravity at Washington.—Preliminary work with brass pendulums has been completed. From the results obtained designs for several pendulums of fused quartz have been prepared. A Shortt clock has been installed for the time measurements necessary.

Elastic hysteresis research.—The source of the discrepancy in the values of the elastic hysteresis modulus, when obtained by measuring the deflection of bars under load and by observing the damping of tuning forks, has been finally located. The results by the two methods agree when, in the static method, the load is applied to both prongs of the tuning fork and the point of loading is selected in accordance with the results of a theoretical study.

Platinum metals.—A simple and accurate method was developed for the determination of osmium. It is now possible to determine each of the six metals of the platinum group with satisfactory accuracy if they have been separated from each other. Completion of a system of methods of separation is the next phase of the research.

A method was developed for preparing spectrographically pure iridium, but it is not satisfactory, either as to speed or yield, for the preparation of reasonably pure iridum in quantity. The very pure metal is needed for other phases of the work on the properties of the platinum metals.

Some modifications were made in the previously developed method for the purification of osmium. It is possible to prepare any one of the six metals in any desired degree of purity.

Metallographic technique.—Many requests have been received for permission to copy the automatic metallographic polishing machine. Using this machine, abrasives and polishing methods suitable for various materials have been studied.

Pure metals and their alloys.—A publication was issued on the properties of rhodium and the methods for mechanically working it. Additional data on the physical properties of nickel of the

highest attainable purity and of thorium have been obtained. In cooperation with the alloys-of-iron research committee of Engineering Foundation a critical review of the literature on the preparation and properties of pure iron has been undertaken. The study of the A_2 (magnetic) change in pure iron by means of the β-ray spectrograph has been continued.

Testing of thermometers.—About 94 per cent of approximately 100,000 clinical thermometers submitted for test were eligible for certification. Tests are now made in conformity with Commercial Standard CS1–28 except for Government purchases under other specifications.

Gas thermometry.—A new manometer was developed for the measurement of gas pressures up to 1.5 meters of mercury with a precision comparable to that attainable in length measurements. Two glass cells, each 6 centimeters internal diameter to minimize capillarity, are connected by a flexible, water-jacketed tube. The distance between the cells is determined by gage blocks. The position of the mercury surface relative to the cell is determined with a precision of about 0.0001 millimeter mercury by means of a special instrument developed and constructed for this work at the bureau. It employs a radiofrequency oscillating circuit which is very sensitive to small changes in electrical capacitance.

Low-temperature cryostat.—An improved cryostat, capable of automatically maintaining temperatures as low as −150° C., constant to better than 0.01° was constructed for use in intercomparing laboratory standards and for use in routine testing.

Application of the glass electrode for pH measurements.—The degree of acidity, commonly expressed as "pH," is important in many chemical processes, including electroplating. The hydrogen and quinhydrone electrodes and colorimetric indicators previously used in these measurements are not applicable in the presence of oxidizing agents. Results thus far obtained indicate that the "glass electrode" may be applicable to chromic-acid baths and other oxidizing solutions.

The chloroplatinate-chloroplatinite electrode.—The electromotive force of this electrode has been found to correspond to a reversible chemical equilibrium. The electromotive force has been measured and the free energy of the reaction determined.

Thickness of adsorbed films of liquids.—Measurements of surface tension of soap solutions have shown that there is no evidence for the existence of thick plastic films on the surface of such solutions. An investigation of the viscosity of liquids in very fine capillarity recently completed has shown that there is no rigid absorbed layer thicker than 0.02 micron on glass or platinum surfaces when covered with liquid, a conclusion of fundamental importance in connection with lubrication.

The molecular weight of hydrocarbons.—An improved Victor-Meyer apparatus has been designed and constructed. By making two determinations, one at 1 atmosphere and the other at 0.5 atmosphere, it is possible to determine the molecular weight with an accuracy of about 0.3 of a unit.

Chemical nature of rubber.—Very pure rubber hydrocarbon has been prepared in the gel form. By cooling an ethereal solution of

this pure rubber the hydrocarbon is deposited in a crystalline form. Combustion analyses have been completed and apparatus is in course of construction for molecular weight determinations and for obtaining photographs of the crystalline rubber.

Detergents.—Information was collected and made available on the preparation and uses of various types of polishes. A circular of information on washing and cleaning materials and their applications was also prepared.

Analytical reagent chemicals.—Fifty-seven individual methods for the determination of various impurities in 30 reagent chemicals were studied and in many cases modified or replaced by better methods. As in other years this work formed a substantial part of the preparation of specifications for reagent chemicals by the American Chemical Society.

Accelerated weathering tests.—It has been found that the simple cycle of continuous exposure to light from a carbon arc with periodic spraying with water gives valuable information on pigmented coatings, bitumens, etc., but is too drastic for varnishes and other transparent coatings.

Durability of spar varnish.—Outdoor exposure starting at two different seasons of the year, laboratory tests, and accelerated weathering tests on a large number of commercial and experimental varnishes showed that while the durability of spar varnish veries greatly, depending on the season exposed, the relative durability of a series of varnishes is quite constant. The accelerated weathering cycle detected the poor varnishes but did not differentiate between good and very good varnishes. The kauri reduction test gave fairly good indications as to durability. Varnishes meeting the Federal specification are above the average in durability, while those made from some of the modern synthetic resins were better than varnishes of the same oil content made from rosin, ester gum, or kauri.

Softening point of bituminous materials.—A method based upon a modification of previously used apparatus and procedure for determining the softening point of materials which have no definite melting point has been developed.

Physical tests for grease.—The Bulkley consistometer has been found useful in studying the properties of grease. Tests have also been made with a long metal capillary under high pressures showing that the curve for rate of flow of grease, when plotted against inlet pressure, passes through a maximum due to the consistency of the grease being made stiffer under high pressures.

Standard analytical methods.—The bureau cooperated with the American Society for Testing Materials in the preparation of methods of analysis for steels, cast irons, and various paint materials, in the preparation of specifications for sampling sheet steel and ferroalloys and tentative specifications for glazier's putty, in exposure tests on the stability of foundry coke, and in investigations on the hiding power of paints and pigments and the tinting strengths of pigments.

Methods for silvering glass.—In connection with the preparation of a new circular on silvering glass, considerable work has been done in refining and improving the technique and simplifying the formulas in order to make success in their use more certain and less

dependent upon previous experience. The new circular will give methods for the chemical deposition of silver, copper, platinum, and lead sulphide, and for the production of mirrors by cathode sputtering and by the condensation of metallic vapors on glass.

Effect of ultra-violet rays on the transparency of special window glasses.—Exposure to the mercury arc diminishes the ultra-violet transmission of these glasses more than exposure to the sun. It has been found that exposure of these glasses to the sun, after their exposure to the mercury arc, raises their ultra-violet transmission above the minimum value obtained with prolonged exposure to the sun. In 17 out of 20 samples, comprising 6 different makes of special window glasses, the recovery was from 1 to 6 per cent above the minimum value obtained by exposure to the sun alone. This recovery appears to be produced by radiation of wave lengths in the region of 365 millimicrons.

Construction of instruments and apparatus.—The bureau's shops constructed many special instruments for the laboratories, including high-grade blown-glass apparatus, and cabinet work such as cases for instruments, besides repairing furniture and woodwork required in the general upkeep of the buildings. Metal specimens for routine tests were machined, and the preparation of standard steel and alloy samples was carried on as before. Apparatus built included the following: Seven resistance standards, air-cooled resistor for current balance, resilience meter, double automatic polishing machine, high-frequency oscillator, wool meter (including optical parts), cathode-ray oscillograph, revolving circuit breaker, flicker photometer, marginal relay, two reflectometers, beat-frequency oscillator, electrostatic voltmeter, hook gage, variable-voltage transformer, expansivity furnace, and an abrasion machine.

Other projects.—In addition to the work described in the foregoing paragraphs, some progress has been made on the following: Determination of the regularities in the arc spectrum of titanium and zirconium, Zeeman effects of spectral lines, the "Raman" effect, density changes and refractive index changes produced in glass by various heat treatments, filters for changing the color temperature of incandescent sources to mean sunlight, standards for index of refraction, aberrations of astronomical objectives, actino-electrical and photo-electrical properties of substances, infra-red absorption spectra of selected compounds, resonance radiation excited by higher series lines, thermal expansion of glass at high temperature, measurements of the difference in index of refraction in striae and the surrounding glass, problems of aerial mapping, thermal conductivity of metals, revision of tests of clinical thermometers, construction of special platinum resistance thermometers, correlation of data on thermal properties of methane, precise measurements of pressures from 1 to 100 atmospheres, measurement of diophantine quantities, preparation of equipment for liquefying helium, platinum resistance thermometry at low temperatures, alloys of platinum metals for resistance thermometry at low temperatures, establishment of a practical laboratory scale of temperatures in the range below liquid-air temperatures, standardization of capillary tube vis-

cometers, rotation viscometers, "bleeding" test for greases, reclamation of used oils, preparation of circulars of metallurgical information, particularly on zinc and cadmium.

EQUIPMENT ($88,000)

Important purchases.—Several important additions have been made to the bureau's laboratory and plant equipment.

Nine large cylindrical weights of 1,000 pounds each with operating mechanism were purchased for the bureau's 100,000-pound deadweight testing machine.

A 3-stage electrically driven compressor for pressures up to 500 pounds per square inch, to be used in the liquefaction of helium, was purchased for the low-temperature laboratory.

A new quartz spectrograph was added to the equipment of the spectroscopy section, while an interchangeable glass spectrograph was purchased for the atomic physics section.

Equipment purchased for the radio section included an aircraft radiobeacon receiver, a short-wave aircraft radio-transmitting set, and a large storage battery of 125 cells.

The surface condenser and auxiliary equipment for the new 750-kilowatt turbo-alternator was purchased and installed in the new central power plant. Two storage batteries of 60 cells each, one having a capacity of 240 ampere-hours and equipped with Plante-type plates, and the other with a capacity of 400 ampere-hours with pasted plates, were also purchased for the bureau's plant.

A 750-horsepower electric motor and high-pressure fan were purchased for the automotive power-plants section. These will be installed in one of the existing altitude chambers to be used in connection with dynamometer testing of air-cooled engines.

A spectrophotometer was added to the equipment of the colorimetry section, and a new drying box and auxiliary equipment were purchased for the semicommercial levulose plant.

A 5 by 8 inch double-geared laboratory rolling mill was bought for the metallurgical division, and a precision bench lathe with 38-inch bed and 8-inch swing has been purchased for the instrument shop.

The equipment of the gage section has been increased by the purchase of 36 sets of internal micrometers with master rings.

In addition, a large amount of smaller equipment has been added to the bureau's power plant, shops, and laboratories.

GENERAL EXPENSES ($64,000)

Maintenance of mechanical plant.—The usual maintenance work, such as the replacement of piping, fittings, valves, etc., has been carried on. A number of changes have been made in piping layouts to facilitate connection to the new power plant.

Electrical construction and repair.—The usual maintenance work on the electrical installations has been carried on, and a great number of new electrical installations incident to laboratory expansion have been made.

Plumbing and pipe work.—In addition to the usual maintenance work on existing pipe work, new extensions to steam, water, gas, air,

and vacuum lines were made incident to the installation of new laboratory equipment. A new water main has been installed to supplement the water supply. Many changes in the pipe work in the north building have been necessary on account of the alterations to be made in that building.

Library books.—The number of volumes accessioned was 1,784 (previous year, 1,639), and 101 were canceled, making the total number of accessioned volumes 35,554. Scientific and technical periodicals received number 1,247, as compared with 1,056 last year.

IMPROVEMENT AND CARE OF GROUNDS ($14,400)

Good progress has been made in improvement of the grounds by grading, sodding, and planting of shrubs. The fill at the east end of the industrial building has been completed and will be seeded this fall.

TESTING STRUCTURAL MATERIALS ($268,150)

City planning and zoning.—Surveys of city planning and zoning laws and ordinances showed further progress in the use of the bureau's recommendations. A pamphlet on the preparation of zoning ordinances was prepared.

Construction economics.—An extensive study was made of the planning and control of public works, and from December on several staff members aided in the department's work of coordinating the activities of Federal, State, and local officials in expediting public-works construction.

Home financing.—A preliminary report has been written on the basis of field work regarding the volume of mortgage writing and cost of administration.

Survey of small-house construction.—A digest of data obtained through a field survey made last year in 31 cities has been prepared for publication.

Care and repair of the house.—A handbook for home owners and those interested in keeping their property in good condition was prepared. It gives simple and specific directions for home repair work and describes tools and materials needed.

Cooperation with other agencies on building and housing problems.—Cooperation was continued with Federal and State agencies and with thousands of local governments and private organizations concerned with building and housing. City planning and zoning, building codes, and home-ownership problems were taken up jointly with bodies such as Better Homes in America with its 6,500 local committees and organizations representing architects, engineers, business, civic, and other groups.

Plumbing investigation.—An extension of the plumbing investigation carried out in 1921–1923 for the building-code committee of the Department of Commerce has been undertaken in cooperation with the industry to include pipe sizes and design of systems for tall buildings.

Preliminary observations and measurements were made on (1) the capacities of drains and (2) the loads carried by the drains under actual service conditions in five large buildings in New York City and in two of the larger Government office buildings in Washington.

Other data pertaining to the loads on plumbing systems in actual service were obtained. An extensive experimental program is planned for the current year.

Building codes.—A survey of the amount and character of combustible contents of typical fire-resistive buildings in Washington, D. C., was made as an aid in classification from the fire-hazard standpoint.

Experimental work to determine the inherent fire hazard and protection required for household heating appliances was nearly completed. This was preceded by a survey of existing conditions in residences and apartments and examination of premises where fires from stoves, furnaces, and their pipes have occurred.

Cement reference laboratory.—The cement reference laboratory, a cooperative project of the Bureau of Standards and the American Society for Testing Materials, conducted inspections at 175 laboratories. Apparatus was tested, methods demonstrated, and miscellaneous data collected. This information is proving valuable in outlining further work of the laboratory. Requests for inspection have been received from 194 laboratories, indicating a widespread interest in this work.

Branch laboratories and inspection of cement.—The branch laboratories at Northampton, Pa., Denver, Colo., and San Francisco, Calif., all test cement, while the Denver laboratory also tests concreting materials and the San Francisco laboratory makes miscellaneous chemical and physical tests. Cement-inspection service was established at six plants. During the year 1,628,187 barrels were sampled and tested and 1,255,947 barrels shipped to Government projects.

Diatomaceous silica.—The effect of adding diatomaceous silica to concrete has been studied. The materials ranged from 7.5 to 34.7 pounds per cubic foot, and most of the material submitted was composed very largely of diatoms. The addition of diatomaceous silica requires the use of more mixing water, the lighter the silica the more water required. Diatomaceous silicas tend to produce a lower strength in concretes of equal flows, but permit a larger flow without the separation of the constituent materials of the concrete.

Waterproofing compounds.—Concrete test specimens containing integral waterproofing compounds subjected constantly to a 20 pound water pressure showed in most cases only a slight permeability at the end of one year. After drying in the air of the laboratory for one month permeability generally increased. At the end of a year the majority of these treatments were of little value. About one-third of the specimens were considered to be sufficiently effective for practical use.

Cast stone.—Some very unusual characteristics were exhibited by samples of cast stone. The modulus of rupture ranged from 200 to 1,500 pounds per square inch. The compressive strength of the best specimen was 23,000 pounds per square inch, and the strength for all specimens 1,500 pounds per square inch. The maximum 48-hour absorption was 13.5 per cent, and the minimum 2 per cent. The resistance to freezing and thawing ranged from complete failure within 40 cycles to specimens that exhibited no signs of disintegration at 500 cycles.

Durability of concrete aggregates.—No one test appears to be suitable for determining the durability of all types of concrete aggregates exposed to freezing and thawing. Petrographic analysis may be used to advantage in determining the merits of the material. The presence of clay in certain forms, such as laminae, seems to cause early disintegration in certain types of rock.

Concrete masonry units.—Tests on 50 samples of concrete masonry units gave compressive strengths from 400 to 2,000 pounds per square inch of gross area. There seemed to be no relation between absorption and compressive strength except that usually the sand units had the greatest strength and least absorption while for cinder and haydite blocks the reverse was true.

The weights of sand blocks varied from 125 to 150 pounds per cubic foot, and cinder units from 70 to 100 pounds. Haydite were the lightest, ranging between 70 and 85 pounds per cubic foot.

Phase study of the system CaO–SiO_2–B_2O_3.—A study of a portion of the CaO–SiO_2–B_2O_3 system has shown that the presence of small amounts of B_2O_3 in dicalcium silicate lowers the refractive index, and also lowers the temperature of the inversion from the beta to the alpha form.

Reaction of water on calcium aluminates and calcium aluminate cements.—The study of the mechanism of the reaction of water on one domestic and seven foreign calcium-aluminate cements, and the ternary compound $4CaO.Al_2O_3.Fe_2O_3$ shows that these cements reacted with water to form a metastable solution in the early periods which approximated the composition of monocalcium aluminate. The boundaries wherein these solutions occur have been determined.

Clays as admixtures in concrete.—In cooperation with an engineering firm an investigation of the value of clay admixtures in concrete has been undertaken.

Survey of common brick.—In cooperation with the Common Brick Manufacturers Association samples of brick from about 200 plants are being tested to determine their compliance with specifications.

Test of large concrete cylinders.—In connection with the design and construction of dams by the Aluminum Co. of America, twenty-three 24 by 48 inch concrete cylinders were fabricated and sent to the bureau for testing. It was found that Poisson's ratio for the concrete was about 0.15 for all stresses within the range from 0 to 1,000 pounds per square inch.

Tests of the Arlington Memorial Bridge.—Continuous records of the temperatures of the concrete in one of the main arch spans are being obtained. The average temperature of the arch has varied between 28° and 80° F. Measurements of the deformations and deflections of the arch barrel caused by temperature changes, both before and after the construction of the walls and roadway, were made to determine the effect of the restraint of the superstructure on the deformations of the arch.

Transmission of water through brick masonry.—The durability of bond between brick and mortar may be improved by finding and using mortars which, under any conditions, undergo relatively small volume changes. It is believed that there are several ways in which this may be accomplished without any material increase in labor or building cost.

Properties of sand-lime brick.—In determining weathering ability, partial immersion as well as total immersion absorption data have been obtained together with the bulk volume and density of the bricks. Freezing and thawing cycles on these bricks are now being made to find whether there is any correlation between absorptive properties and resistance to freezing and thawing.

Manufacture of gypsum products.—Properties of gypsum fiber concrete: Volumetric changes of gypsum fiber concrete made from five different lots of calcined gypsum are being studied. Setting expansions range from 0.06 to 0.40 per cent. Within the temperature range of 25° to 45° C. the thermal coefficient of expansion of the neat gypsum specimens is about 160×10^{-7} and that of the fiber concrete containing 12.5 per cent wood chips about 130×10^{-7}.

Lime investigation.—(a) Soundness of hydrated lime: Steaming a paste of hydrated lime in an autoclave at 120 pounds pressure has proven most satisfactory to determine the soundness of hydrated lime. It is hoped that the method may also be made applicable for testing the soundness of pulverized quicklime.

(*b*) Particle-size distribution of hydrated lime: The particle-size distribution of hydrated lime is being studied by determining the rate of sedimentation of lime in anhydrous normal butyl alcohol.

(*c*) Specifications for chemical lime: Recommended specifications for quicklime and hydrated lime for use in soap making have been published.

Elastic pointing materials.—A special apparatus which has materially simplified the testing process has been designed and built to determine the effectiveness of these materials in masonry joints when subjected to tensile stresses.

Slate.—Samples of roofing slate were secured from old buildings where they had been exposed under service conditions for periods ranging from 12 to more than 100 years. This has afforded considerable information on the nature and causes of slate weathering. Some deposits of slate in this country seem to be very resistant to destructive weathering agents, while others may not be good for more than 25 years of service.

Blistering of vitreous enamels on gray cast iron.—This work in cooperation with the American Ceramic Society shows that "blistering" irons possess a much narrower range of temperatures within which the enamel can be burned without blister formation than do nonblistering irons. The range of suitable firing temperatures for a given iron corresponds with a decrease in the rate, or a cessation of the oxidation of carbon from the surface of the iron. Rapid oxidation of carbon from the surface is believed to reduce the presence of "temper carbon," a very finely divided carbon formed immediately in the breakdown of cementite and previous to agglomeration to the coarser "graphite carbon." In general, the removal of the surface layer from a "blistering" iron renders it "nonblistering" in its behavior when enameled.

Chemical testing and methods of analysis.—Samples of structural materials were tested for various branches of the Government. These included Portland cement, cast irons, steels, alloy steels, ferro-alloys, brasses, bronzes, bearing metals, boiler plugs, Monel metal, and light aluminum alloys. Several improved and more rapid test methods were developed.

TESTING MACHINES ($41,000)

Hardness testing of metals.—During the past two years, a large number of steel specimens, having high Brinell numbers, have been tested. The results have been used in the derivation of formulas for the relation between the Rockwell and the Brinell numbers. The new formulas do not differ greatly from earlier formulas published by the Bureau of Standards but give the metallurgical industry more reliable methods of obtaining the Rockwell number from the Brinell number or vice versa. Recommendations have likewise been prepared covering the use of the Brinell machine, which should secure greater uniformity in test results from different observers.

Electrically welded steel tubing.—The physical properties of tubing made from sheet steel containing from 0.08 to 0.25 per cent carbon, in which the longitudinal seam was welded under pressure by the electrical-resistance method were determined. Seven different tests were applied, which showed that the properties of the base metal (the metal not affected by the welding operation) can be used in determining the working stresses for different structural uses of tubing made by this process.

Flat plates under edge compression.—In the pontoons or floats of seaplanes and in the outer covering of airplane fuselages flat plates are subjected to compressive forces in the plane of the plate. In order to determine the loads such plates can carry, an investigation was conducted in cooperation with the Aeronautics Branch. Tests were made on four different materials—nickel, duralumin, stainless iron, and Monel metal, having thicknesses up to 0.095 inch, a length of 24 inches (direction of load), and widths up to 24 inches. It was found that the plates could be subjected to an increase of load after they had begun to buckle and that especially in the thinner and wider specimens it was possible for the plate to carry many times its theoretical buckling load under uniform thrust without permanent deformation.

Fixation of struts.—The strength of tubular steel struts as used in airplane fuselages, loaded in compression and with their ends restrained, is being determined in cooperation with the National Advisory Committee for Aeronautics and the Navy Department. Various conditions of end support, varying from no restraint to infinite restraint are being used, and it is expected that the results of this investigation will enable designers to reduce the weight of aircraft structures with safety.

Welded structures.—In cooperation with the structural steel welding committee of the American Bureau of Welding, tensile tests have been made of 125 large welded joints, as an aid in determining safe working stresses when designing welded structures.

Torsional properties of tubing.—An investigation of the torsional properties of tubes for aircraft structures has been undertaken in cooperation with the Bureau of Aeronautics, Navy Department. The first tests are being made on standard sizes of chrome-molybdenum steel tubing up to 2 inches in diameter and up to 0.065 inch thick. These specimens fail by buckling after permanent deformation of the material has begun. These results will enable designers to estimate closely the torsional strength of tubular members of aircraft.

Specifications for empty shipping containers.—With the cooperation of the Forest Products Laboratory and the industry, tentative specifications have been prepared for solid-fiber boxes, corrugated-fiber boxes, nailed and lock-corner wooden boxes, plywood boxes, and wire-bound boxes. Specifications for sheet-steel drums and for cylinders for compressed gases are in preparation.

INVESTIGATION OF FIRE-RESISTING PROPERTIES ($30,000)

Furnace for fire tests of walls and partitions.—A new gas-fired furnace for conducting fire tests of wall and partition constructions was completed which accommodates specimens 11 feet high and 16 feet wide and in which loads up to 350,000 pounds can be applied.

Tests of fire-detecting systems.—Tests were made of five automatic fire-detecting systems for the Steamboat Inspection Service to determine their acceptability under the law requiring their installation on passenger vessels.

Fire tests of roofing materials.—Data on fire tests of roofing materials in common use were prepared for publication. These included new materials, and similar materials from roofs 5 to 30 years old, as well as new and weathered roofings covered or impregnated with fire-retardant compounds.

Spontaneous heating and ignition of materials.—Determinations of ignition temperature and susceptibility to spontaneous heating of various materials have been made at the request of other Government departments, using available equipment and methods. Additional fundamental test methods for this work are being developed.

Research on the susceptibility to spontaneous heating and ignition of jute is being conducted in cooperation with the Bureau of Chemistry and Soils of the Department of Agriculture and a committee of the Marine Underwriters. The results indicate that jute presents no greater hazard from this standpoint than other materials that are generally regarded as presenting at the most a low hazard.

Other active research projects.—Plans for temporary equipment for fire tests of welded steel floor constructions, to be conducted in cooperation with the American Institute of Steel Construction, were completed. Fire tests were made of columns protected by precast and poured gypsum. Work was continued on the report giving results of compression tests of steel and cast iron at high temperatures. Fire, impact, and loading tests were made of insulated safes to obtain data for revision of Federal specifications. Tests were made to determine the effectiveness of fire-retardant surface treatments for wood scaffolding.

Technical assistance was given in connection with tests of sprinkler systems in airplane hangars, conducted by the Aeronautics Branch, and in the formation of an organization of Government officials concerned with fire prevention.

INVESTIGATION OF PUBLIC-UTILITY STANDARDS ($107,290)

Measurement of high voltages and large currents.—The large absolute high-voltage electrometer was operated in some preliminary trials at 90,000 volts and showed the expected sensitivity. Modifi-

cations have been made to reduce air-current disturbances. A special microscope has been constructed for determining the location of the attracted disk relative to the guard ring.

A standard current transformer and accessory apparatus, which have been completed, raise the possible range of testing from 2,500 to 6,000 amperes.

Electrical codes.—Assistance was given in completing the revision of the Wisconsin State Electrical Code. The preparation of a pictorial edition of the National Electrical Safety Code was continued. In cooperation with a national committee, specifications for testing line insulators of more than 750 volts were completed. Assistance was rendered the International Electrotechnical Commission on regulations for overhead transmission lines and the National Board of Fire Underwriters in revising the National Electrical Code.

Protection against lightning.—Miscellaneous Publication No. 95, entitled "Protection of Electrical Circuits and Equipment against Lightning," was issued. Assistance was given the National Fire Protection Association in the preparation of a report dealing with oil tanks, and an investigation was carried on in the oil fields of California, Oklahoma, and Kansas.

Government telephone service.—The bureau's work on telephone service has been directed almost entirely to the planning of efficient and economical service for Government offices in Washington and elsewhere, and to the defense of damage suits involving very large claims for telephone equipment used here and abroad during the war period.

The first unit of a group of dial private-branch telephone exchanges planned to serve in a properly coordinated and throughly modern manner the executive departments and establishments in Washington was put into service May 31. For the new Commerce Building, which will house all of that department's activities except the Bureau of Standards, a consolidated, combination dial and manual, private-branch exchange has been designed.

Detailed studies were carried out for the Budget Bureau on the telephone service for Federal agencies in cities outside of Washington, and recommendations were made for Asheville, Chicago, Fargo, Kansas City, San Diego, San Francisco, and Springfield, Ill.

Underground corrosion.—About 3,000 specimens of pipe materials have been removed from 70 locations. Their condition and that of the soil in which they were buried are being determined. This is part of a 12-year project now two-thirds completed.

Field tests of 50 protective coatings in 29 soils have been started with the cooperation of coating manufacturers, the American Gas Association, and the American Petroleum Institute, who will bear about two-thirds of the expense of the investigation.

Hotel ranges.—The efficiency of ovens and cooking tops of hotel gas ranges was measured and a limited amount of work was done on domestic electric ranges to assist Government institutions, such as hospitals, barracks, etc., in the selection of such equipment.

Corrosion of materials for gas-oven linings.—A large number of materials have been tested by an improved method. The corroded materials have been submitted to a committee of the American Gas Association, which contributed to the research as an aid in preparing specifications.

Domestic range burners.—An investigation of the optimum design of domestic gas-range burners for using carbureted water gas was conducted to find how design factors differ when using water gas as compared with propane and butane previously studied.

Use of propane in the Lighthouse Service.—It has been found that propane burners could be substituted for the kerosene burners now used for the larger lights with a simplification of equipment requiring less attention from the operator, and with the same efficiency in terms of candlepower-hours per thousand British thermal units. The greater cost of propane at the present time probably makes its substitution for kerosene inadvisable except possibly for unattended stationary lights.

TESTING MISCELLANEOUS MATERIALS ($46,400)

A great variety of tests were made for Government departments on paints, varnishes, roofing and waterproofing materials, rubber goods, packings, inks, typewriter ribbons, carbon paper, textiles, boiler waters and compounds, detergents, chemicals, gold alloys, etc. Miscellaneous materials were tested to determine their fire hazard to guide the Steamboat Inspection Service in making rulings on the transportation of commodities on passenger vessels.

RADIO RESEARCH ($85,700)

Primary frequency standard.—A primary frequency standard with an error of one part in several millions, consisting of four special piezooscillators of great accuracy, has been in operation for several months. Currents are furnished by this standard at 100,000, 10,000, 1,000, 100, and 10 cycles per second, and seconds impulses are given. These accurately known frequencies can be made available for measurement purposes in most of the bureau's buildings. The frequencies of the four piezooscillators are found to increase at the rate of about one part in a million per month.

Secondary frequency standards.—Some of the causes of erratic behavior of temperature-controlled piezooscillators constructed by the bureau have been eradicated by improvements in design. Two of the best piezooscillators maintain their frequencies from day to day within ± 1 part in a million. The frequencies of this group of piezooscillators have been found to increase about one or two parts in a million per month.

Standard frequency dissemination.—Regularly scheduled transmissions of eight frequencies per month were sent out for the use of all those interested in accurate frequency calibration. The accuracy of these transmissions is better than 0.01 per cent.

Intercomparison of frequency standards of various laboratories.—The frequency standards of several foreign countries were intercompared by carrying a piezooscillator to the different laboratories and by measurements on a quartz light resonator circulated by Japan. The latter measurements showed the national standards of four nations to be in agreement within 0.002 per cent.

Measurement of radio field intensity.—Field intensity measurements made at frequencies from 550 to 5,400 kilocycles per second over distances up to 3,200 meters over fresh water show that 15 per

cent of the signal is absorbed at 1,500 kilocycles and about 50 per cent is absorbed at 5,400 kilocycles. Measurements of transmissions from broadcasting and Government stations at distances up to 270 kilometers show that the absorption at a distance of 270 kilometers is 99 per cent for a 760-kilocycle transmission and 90 per cent for a 338-kilocycle transmission.

Variations of radio wave intensity and direction.—Measurements with an automatic fading recorder at the Kensington field station show that magnetic storms do not affect the received intensity but increase atmospherics. The eclipse of April 28, 1930, did not affect the records.

Height of the Kennelly-Heavyside layer.—Oscillographic records made on pulse signals sent by NKF on 4,045 kilocycles and 8,650 kilocycles show the virtual height of the Kennelly-Heaviside layer to be from 225 to 250 kilometers on 4,045 kilocycles and about 290 kilometers on 8,650 kilocycles. A 100-kilometer layer was also observed on the lower frequency. The height of the layer changes during the day and is affected by magnetic storms.

Studies of piezo-electricity.—The modes of vibration of crystalline quartz plates of various cuts have been studied by observing the patterns formed by lycopodium powder on the surfaces of the plates. The air currents emanating from the periphery of a vibrating circular plate have been utilized to determine the angle of vibration of the plate. The experimental work has been accompanied by a theoretical study of the problem of free vibrations of an elastic solid.

Radio-frequency power factor of mica.—Power-factor measurements between 100 and 1,000 kilocycles per second were made on 34 samples of domestic and foreign mica for the Bureau of Mines for use in a report to the War Department.

COLOR STANDARDIZATION ($15,800)

Filters for the reproduction of sunlight and daylight and the determination of color temperature.—A series of filters reproducible from chemical specification has been developed for use in photographic sensitometry, colorimetry, and photometry. One has been recommended for adoption as a standard of artificial sunlight by the Seventh International Congress of Photography. Others are being considered for adoption as standards by the subcommittee on colorimetry of the International Commission on Illumination.

Theory of reduction of mixture data in colorimetry.—A paper on the mathematical treatment of physical properties which determine the colors of reflective and transmissive materials and on the data which give the properties of the average normal eye has been published.

Standardization of Lovibond glasses.—Two hundred and twenty-five Lovibond red glasses submitted by users have been compared with the bureau's standard glasses. In addition, 36 glasses submitted by the makers, Tintometer (Ltd.), of England, and 19 belonging to the American Oil Chemists' Society were compared with the standards.

New color comparator for incandescent lamps.—The experimental conditions affecting accuracy of comparison of two colors have been

studied, and a comparator designed for incandescent lamps has been constructed. It has been found that the precision is about double that obtainable with the comparator previously used.

Miscellaneous.—Lack of space prevents more than mention of the following investigations on which work has been done during the year: Analysis of color stimuli in terms of dominant wave length and purity, selection of a standard neutral stimulus for colorimetric purposes, color specifications for railway and traffic signals, diffuse reflection and its measurement, and standard data on reflection of various materials.

INVESTIGATION OF CLAY PRODUCTS ($49,000)

Crazing of semiporcelain dinner ware.—The effect of composition and physical structure on changes in volume, as produced by reactions of water-permeable bodies with moisture, as well as the nature of the reaction itself, are being studied with the autoclave. It appears that bodies of more than 2 per cent water absorption will undergo a sufficient change in volume when subjected to moisture to rupture or craze a glaze coating. Feldspar may undergo greater volume changes than clay matter and a temperature of at least 240° C. is required to remove the moisture causing this change in volume and to complete the accompanying volume contraction.

Cutlery marking of chinaware.—Permanent marking of chinaware by cutlery appears to be due to the formation of an extremely thin layer of lead sulphate on the surface of the glaze during the manufacture of the ware. One manufacturer was able to produce ware no longer susceptible to this cutlery marking by substituting an electrically heated muffle for the firing of his decorated ware.

Study of feldspar.—A tentative commercial standard classification for feldspar has been established. The suggested specification is entirely technical in nature and is based on an investigation of 19 commercial feldspars which has been carried on for several years.

Study of fire clays.—Data obtained on 26 representative fire clays show that their thermal expansions after firing at 1,400° C. may be greater or less than after firing at 1,155° C., depending on their composition. The moduli of elasticity and rupture of the clays are generally greater after firing at 1,400° C. than after firing at 1,155° C. The percentage increase is greater in highly siliceous clays than in aluminous clays. The plastic deflections of the clays are also less in the siliceous type of clays than in the aluminous.

Problems relating to saggers.—It has been found that the life of saggers made from individual bodies is directly related to small changes in porosity, but because of the importance of other properties, which have also been determined, the porosity of a series of different bodies apparently does not bear an important relation to their life when subjected to thermal shock.

Effect of variations in composition on vitreous enamels.—Two vitreous enamels having identical calculated melted compostions, but differing in their raw batch mixtures, were prepared. The cone formation temperatures of the two resulting enamels differed by approximately 40° C. Additional heat treatment at the temperature of preparation (1,250° C.), was given and records obtained of the cone

deformation temperatures and indices of refraction. These indicate that the initial difference in properties is due to a more stable condition than that of mere arrested reaction.

Resistance of metals to the abrasive action of plastic clay.—Comparative wear values of 12 metals and alloys have been studied with the following results, the resistance of a chrome-nickel-tungsten composition being used as unity: Carbon-cobalt-chromium, 2.3; average for several cast irons, 30.9; carbon-chromium-nickel steel, 39.1; electrolytic copper, 161; and manganese-zinc bronze, 276.8.

Casehardened metals are not suitable for continuous abrasive resistance. As soon as the outer layer is worn away the successive layers become less wear resisting.

Hollow-ware dies.—This investigation has shown that within reasonable limits both "core" and "die" length have a more marked effect on power consumption than taper without a proportional improvement in the column structure. Hollow-ware dies that are too short produce columns with serious defects. Taper affects the column structure more than it does power consumption and rarely should be less than 3° for both cores and die.

Compressible lubricants such as steam and air are far more efficient, easier to control, and less liable to damage the product than liquids, such as water and oil.

Properties of architectural terra cotta.—In cooperation with the National Terra Cotta Society, about 190 buildings containing terra cotta were inspected to determine the serviceability of this ware. Laboratory research is being conducted to improve the structure of this material and to develop better methods of manufacture and setting.

Ceramic bodies (except mixtures containing blast-furnace slag), with high-moisture absorptions, developed considerable expansion. Bodies with low absorptions composed of pure clay and feldspar developed practically no moisture expansion, while those composed of clay, feldspar, and more than 20 per cent silica developed considerable moisture expansion. By adding magnesite the resistance of a ceramic body to moisture expansion was improved. Additions of whiting, iron oxide, and titanium oxide were not as beneficial as magnesite.

It was found that crazing caused by moisture expansion of bodies can usually be prevented by proper manufacturing control.

Columbus laboratory.—As the result of experimental work on 118 glazes and glasses, it is now possible to approximate by calculation values of tensile strength, Young's modulus of elasticity, and mean linear coefficient of expansion of a glaze in the temperature range from 25° C. to the lower limit of the critical range. The investigation of English and domestic china clays and kaolins is nearing completion. The separation and study of collodial material has been applied to the investigation of representative alluvial and glacial clays, the data indicating that slaking time, tempering water, drying shrinkage, and "green" modulus of rupture tend to increase with increase in the quantity of colloidal matter. A new method has been developed for studying the relative resistance of refractories to slag attack in boiler settings.

STANDARDIZING MECHANICAL APPLIANCES ($29,300)

Testing of engineering instruments.—The number of calibrations of water-current meters and other engineering instruments now exceeds 1,000 per year. Experimental work was done in cooperation with the United States Geological Survey in the development of new standard suspension arrangements for water-current meters.

Investigation of propeller fans.—In cooperation with a manufacturer the performance of 2-blade propeller fans has been measured for a wide range of pitch-diameter ratios and the results of the measurements prepared for publication in the Journal of Research.

Fire-extinguishing appliances.—The testing and investigation of fire-extinguishing appliances, principally for the Steamboat Inspection Service, has been further extended to include additional devices and new types of equipment. The volume of this work has more than doubled in the past year.

Elevator safety interlocks.—Additional commercial interlocking devices have been tested, and the data made available to certain regulatory bodies, as, for example, the Federal Government, certain State governments, and casualty insurance companies. These performance tests have recently been adopted, substantially in the form originally developed, as a part of the American Standard Code for Elevators.

Automatic postal machines.—Cooperation has continued with the Post Office Department in the technical study and testing of automatic postage-vending and postage-metering machines from the standpoint of mechanical design, accuracy, and reliability for use by the Government.

Numbering machines.—Numbering machines of the lever type have been tested for compliance with Federal specifications. Performance specifications are being developed for numbering machines of other types.

Thermostatic radiator traps.—The new Government construction program requires a great many thermostatic radiator return line traps, and an unusually large number of tests of these traps have been made during the year.

INVESTIGATION OF OPTICAL GLASS ($27,300)

Production of optical glass.—Thirty-one pots embracing six different kinds of optical glass were made in attempts to improve melting procedures and to obtain consistently satisfactory quantities of good glass.

Blanks numbering 12,552 and weighing approximately 2,670 pounds were molded and annealed, the majority being used by the Navy Department.

Viscosity of glass.—Four hundred and six viscosity determinations have been made on five kinds of optical glass. The most probable values, as shown by graphical analyses of data, are as follows:

Kind of glass	Viscosity (poises) at—				
	1,000° C.	1,100° C.	1,200° C.	1,300° C.	1,400° C.
Barium flint	8,510	1,514	403	149	74
Light barium crown	6,840	858	234	94	60
Borosilicate crown	3,390	667	221	120	100
Medium flint	2,140	672	253	110	50
Dense flint	2,100	490	190	93	54

Physical properties of glass as affected by thermal treatment (including annealing).—Tentative values for the increases in refractivity and density of dense barium crown glass have been found to be respectively 0.000057 and 0.00044 per degree centigrade decrease in the effective annealing temperature. This temperature is determined by the character of the annealing and is essentially that temperature at which the glass is in physiochemical equilibrium; that is, continued annealing at this temperature causes the glass to show no further increase or decrease in either density or refractivity.

Gases dissolved in glass.—More satisfactory methods have been developed for determining the gases in glass which can be removed at high temperature by evacuation. Since these gases probably have appreciable effects on the properties of the glass and may be the undetermined cause of serious difficulty in the working, the development is of considerable importance.

Relations between chemical composition, density, and index of refraction of glasses.—Data obtained from the index of refraction, density, and composition of 40 glasses of the soda-lime-silica series lead to the conclusion that the index of refraction (N) and density (D) of these glasses can be computed from the following:

$$N = a + b + c$$
$$D = a' + b' + c'$$
$$a = 0.042712(A)^{0.79487} - 0.2$$
$$b = 0.0153\ B - 0.00837$$
$$c = 0.017219\ C - 0.00103$$
$$a' = 0.07977\ A\ (86.5 - A)^{0.42107} + 2.203\ A$$
$$b' = 2.0150\ (B - 0.5)^{1.065}$$
$$c' = 0.03415\ C\left(\frac{A}{B}\right) - 0.04743$$

in which A, B, and C are the percentages of silica, soda, and lime in the glass.

The composition of any glass of this series can be determined from its index of refraction and density.

Weathering of sheet glass in storage.—A study of this problem has been undertaken to determine, if possible, the conditions necessary to prevent the fogging or surface deterioration of window glass during storage and the consequent loss to manufacturers of many thousands of dollars annually.

INVESTIGATION OF TEXTILES, ETC. ($53,900)

Silk weighting.—In cooperation with the Silk Association of America, National Retail Dry Goods Association, National Better Business Bureau, the American Home Economics Association, and

other national bodies, technical studies have been made on the effect of tin weighting on the properties of silk. It was found that not only the amount of weighting, but also the method of applying it, the construction of the fabric, and other factors have an important influence on serviceability. The effect of diffuse light on weighted silks was studied. A standard method for determining the amount of weighting on silk was developed.

Cotton fabric for parachutes.—In cooperation with the National Advisory Committee for Aeronautics, improvements were made in cotton fabric for parachutes, which increase the resistance to tear. At the present time, at least two commercial firms are producing fabric suitable for parachutes.

Coarse fabrics (bagging, etc.).—In studying the requirements of specific uses in the coarse-fabric field, a systematic study of the relationship between the properties and the twist, yarn number, and construction was made. This investigation required the making of 320 fabrics in the bureau's cotton mill.

Textile test methods.—A simple method has been devised for specifying the slipperiness or smoothness of a fabric by measurement of the coefficient of friction between two pieces of the material. A "flexometer" for measuring the energy required to fold the fabric and the energy which is recovered when the sample is allowed to unfold has been built. This gives data on the tendency to wrinkle. It is believed that the flexometer can also be applied to the evaluation of draping quality. An apparatus for rapidly measuring the thermal transmission of fabrics has been built.

Permanence of papers.—The testing of representative current commercial writing and printing papers in reference to their probable stability has been practically completed. Progress was made in the preparation of similar types of papers in the bureau's paper mill. These papers will have a definitely known history, and the chemicals and mechanical processes used in their preparation are being varied to measure their effect on paper stability. With a fund granted by the Carnegie Foundation, extensive surveys of library storage conditions and a study of their effects on papers are being made. The information so far gained shows that the degree of purity of papers and their strength are the important factors in their permanence.

Government papers.—Additional information was published on the currency-paper study. Various treatments for protection of the paper money against surface wear, which is now the main limiting factor in its life, were investigated. In the cooperative investigation with the Bureau of Engraving and Printing on postage stamps, the type of paper used was found to be the most important factor affecting adhesion of stamps. Through experimental studies, a thinner and more flexible paper was developed. Since the adoption of this type of paper, complaints respecting nonadherence of stamps have decreased to a satisfactory minimum.

Paper testing methods.—A report was published on the bursting-strength test, including a discussion of the alleged variables in this test, and precautions were suggested for minimizing the effect of the more significant variables. An additional publication on the standard type of folding tester was issued. Progress was made in

obtaining information on the application of hygrometry to the special conditions of laboratory testing. The cooperative work with the Technical Association of the Pulp and Paper Industry on the development of official association paper-testing methods resulted in the completion of a method for unimpregnated roofing felt, and revision of the methods for paraffin, starch, and fiber composition.

Miscellaneous.—Additional work under this fund has included an investigation of substitutes for chromium in dyes (for the War Department), the development of a white stainless mineral oil for knitting machines, studies of several new materials, including New Zealand flax, for paper making, and the establishment of standards of quality for several paper products.

SUGAR STANDARDIZATION ($75,000)

The structure of the sugars.—In the bureau's study of the molecular structure of sugar a number of new compounds and methods have been found, among which were (1) a method for separating methyl glycosides which yielded two crystalline methyl gulosides, and (2) a method for deacetylation by means of a small quantity of barium methylate which gave monoacetylglucosido-mannose, a representative of a new type of sugar derivatives. The general problem of a possible relation between optical rotation and atomic dimension was attacked, and what is known as the fluorating process for sugars was studied. Four new crystalline compounds of levulose were prepared.

Crystallographic studies of the sugars.—The identification of crystals and the determination of their crystallographic properties has become an indispensable aid to the advancement of knowledge in the carbohydrate field. The bureau's facilities for this work have been extended, including microphotographic work and the actual growing of perfect crystals under controlled conditions. A study of crystalline turanose, a little-understood rare sugar, has been completed.

Standardization of sugar products.—The problem of suitable specifications and standards for commercial sugars has long been one of the outstanding problems in the sugar industry. Numerous representative samples of white granulated sucrose were carefully studied by means of spectrophotometric analysis, and existing knowledge of the small but all-important amount of color remaining in these so-called white products was materially extended thereby. It is expected that these data will be of assistance in the classification of commercial sugars according to color. An important by-product of this work was the simplification and improvement of some methods used in sugar colorimetry.

Hard refined levulose production.—Portions of the bureau's plant for the semicommercial production of levulose were placed in operation and studies made of the functioning of various steps in the process. Several new pieces of equipment were developed. Constant improvement has been made in a system of analyses of levulose products, and the densities, rotatory powers, and refractive indices of pure levulose solutions have been determined. Two new crystalline difructose anhydrides have been discovered. Approximately 50 tons of artichokes were extracted and the juice concentrated to furnish a continuous supply of material for factory experimentation

Miscellaneous.—In addition to the items described above, progress has been made on the following investigations: The rotation and rotation dispersion of rare sugars for certain wave lengths of light; spectrophotometric measurement of the color of soft sugar; preparation of pure sugars; a standard sugar color, its absorption spectrum, luminosity, and classification; an optical method for the identification of various sugars; the lime precipitation of levulose and its crystallization from aqueous solution; preparation of ribose; identification and properties of unknown constituents of hydrolyzed inulin; the polysaccharides of the Jerusalem-artichoke and similar plants; investigation of the relation of optical rotation to atomic dimension; and the application of the fluorating process to sugars.

GAGE STANDARDIZATION ($40,000)

Certification of master gages.—The measurement and certification of the accuracy of the dimensions of master gages has constituted a large part of the work, and, as in other recent years, the master gages of the American Petroleum Institute have constituted an important item. The measurement of the grand and regional masters of American Petroleum Institute rotary tool joint gages has been practically completed. The principal manufacturers of sucker rods are now supplied with approved gages. Increased tolerances (not, however, inconsistent with approved gaging practice) are now being used on these gages. Master gages were also submitted by many automobile manufacturers, and there was a 70 per cent increase in the number of precision gage blocks tested.

New equipment.—A comparator for long gage blocks and end standards up to 60 inches in length and a lead-testing device were designed and constructed in the bureau's shop. An improved lead-testing device for large thread plugs and rings was made, and a device for measuring angular displacements or spacing, to an accuracy of about 5 minutes of arc, was purchased.

Method of gaging fish nets.—At the request of the Bureau of Fisheries an investigation has been started of methods of gaging the mesh of gill netting. Preliminary results show that "as fished" condition rather than the factory condition should apply when making measurements.

Interchangeable ground-glass joints.—Nine sizes of joints have been adopted as commercial standards for chemical glass apparatus. All have a taper of 1 in 10 on diameter. Steps have been taken to secure gages of the required accuracy for use as masters.

INVESTIGATION OF MINE SCALES AND CARS ($13,400)

Tests of mine scales.—The mine-scale testing equipment was operated in the eastern coal fields. Tests were made of 185 scales used for weighing coal or clay at the mine. Sixty-three scales, or 34.1 per cent, were within the tolerance, while 122, or 65.9 per cent, were found to be incorrect. Installation practices and operating conditions at mines are not favorable to maintenance of weighing machinery within current tolerances.

Protective coatings for heavy weights.—Research was begun on adequate corrosion protective coatings for industrial test weights of large denomination. The condition of a great number of weights treated with a variety of recommended protective coatings and subjected to practical conditions of use will be recorded from time to time.

METALLURGICAL RESEARCH ($51,000)

Heat-treated bridge wire.—The strength necessary in wire for the cables of suspension bridges may be developed by cold working or by heat treatment. Wire of the former class is, however, used exclusively for this purpose, since attempts to use heat-treated wire have been unsuccessful. Various tests, including thermomagnetic analyses, endurance, and other mechanical tests have been made on rejected heat-treated wire. The work will be continued with special attention to the effect of surface conditions arising in the zinc-coating operation upon the stability of the wire under various conditions of stress.

High-speed tool steel and the machineability of steel.—A report has been issued on the characteristic behavior of tools of high-speed steel containing various addition elements, of which cobalt is the only one which appears to be beneficial in its effect. A report was also published on the method for studying the behavior of tools when used for finishing cuts. A similar report on the behavior of sintered tungsten carbide lathe-cutting tools has been published.

Rail steel.—The tensile properties of rail steel at temperatures ranging from normal room temperature to one somewhat below the rolling temperature of the rails have been studied, and the probable relationship determined between the low ductility observed at the elevated temperature—"secondary brittleness"—and the development of transverse fissures in the rails later in service.

Further work is in progress on rail steel of various compositions and heat treatment in the endeavor to establish the cause of the phenomenon of "secondary brittleness."

Fusible boiler plugs.—Changes have been recommended in the specifications for fusible-tin boiler plugs, one, which has received the approval of the Steamboat Inspection Service, being that maximum impurities in the tin filling of 0.7 per cent will be allowed instead of 0.3 per cent as heretofore.

Properties and new uses for bismuth.—In cooperation with one of the large producers a study has been made of bismuth and some of its alloys. This little-used metal possesses some interesting properties which should make it of value industrially.

Foundry materials and methods.—Cooperation with the Steel Castings Research Bureau in the study of steel castings has been continued. The problem of "liquid shrinkage" of cast metals (in cooperation with the American Foundrymen's Association) has included a study of methods for determining the volume changes undergone by metals cooling from the liquid state to room temperature. Data obtained permit construction of the complete specific volume-temperature curve from room temperature to a temperature considerably above the melting point of the metal. These tests are being applied in a practical manner to a variety of cast irons.

The test for determining the ability of molten metal to fill a mold completely has been modified and greatly improved.

Metals of the platinum group.—The study of the refractories for use in melting metals of the platinum group has been completed, while that on the properties and mechanical working of the rhodium-platinum alloys is nearly finished.

Additional research projects.—In addition to the items already mentioned some progress has been made on a revision of specifications for copper-base casting alloys, on a study of the effect of impurities on bearing bronzes, on exposure tests of art bronzes, endurance tests of metals, test methods for foundry sands, accelerated corrosion testing, corrosion of locomotive boilers, and a study of the crystal structure of metals.

HIGH-TEMPERATURE INVESTIGATION ($10,200)

Freezing point of platinum.—The freezing point of pure platinum was found to be 1,773° C. on the international temperature scale. It is estimated that the result is not in error by more than 2° C.

Freezing point of bismuth.—The freezing point of bismuth of very high purity was determined with a platinum resistance thermometer as 271.3° C. on the international temperature scale.

Thermoelectric properties of metals and alloys.—The electromotive force against platinum of a series of platinum-rhodium alloys with rhodium content from 1 to 100 per cent was determined last year from 0° to 1,200° C. This year the investigation has been extended to include a series with rhodium from 0.001 to 1 per cent.

The electromotive force against platinum of nickel of very high purity and of spectroscopically pure zinc and cadmium was determined from 0° C. up to the melting points of these metals.

Investigation of pyrometer protection tubes.—The rate of passage of air through the walls of pyrometer protection tubes at a series of temperatures up to 1,300° C. was determined for 51 primary tubes of 14 different types and 17 secondary (metal) tubes of 8 different types, representing practically every type of pyrometer tube used in this country.

The investigation showed that, in general, if a tube was gas-tight at room temperature, it was practically gas-tight up to the maximum temperature at which the tubes were tested.

Miscellaneous.—Other investigations under way include: Determinations of freezing points of several metals, correlation of high temperature tests of dental gold alloys, effect of high temperature on mica and special refractories, and methods for making ceramic shapes for laboratory use.

SOUND INVESTIGATION ($11,260)

Acoustic properties of building materials.—An improvement in method has been effected by which sound-absorption measurements are taken by means of instruments, eliminating the variable human ear as a factor. The study of soundproof walls for airplane cabins has been continued, and some 20 combinations have been tested. These have not given better results than those tested last year and described in the bureau's Journal of Research for May, 1929.

Ultrasonic waves.—Experiments have been conducted on the speed of ultrasonic waves in certain liquids. By means of measurements of this character it is possible to determine the adiabatic compressibility of a liquid and of a solid suspended in a liquid in which it does not dissolve.

INDUSTRIAL RESEARCH ($204,000)

Storage-battery construction and operation.—Attention has been devoted to the use of lead oxides whose physical and chemical properties have been the subject of previous study. Experimental work has been done on pasting formulas, pickling, and formation of storage-battery plates. Batteries have been assembled from these plates and tested for electrical characteristics. Equipment for the automatic control of such tests, by which it is hoped to increase the output but decrease the labor of making the tests, has been designed.

Insulating liquids.—Four insulating liquids of high purity have been prepared, namely, pentane, hexane, heptane, and octane. Apparatus for measuring the conductivity of liquids after distillation in a vacuum has been assembled and tested.

Landing altimeter.—Altimeters of the aneroid type were tested for drift, seasoning, secular error, and temperature errors with special reference to their use during the landing of aircraft. Flight tests were also made. When using sensitive altimeters of the best quality now available and applying such of the instrumental corrections as are determinate, a residual uncertainty equivalent to about 40 feet in altitude was found to exist.

Wind pressure on structures.—Additional measurements of wind pressure have been made on the power-plant stack, and a paper has been prepared giving all the information available on the wind pressure on circular cylinders and chimneys.

Measurements of the distribution of wind pressure over a model of one type of factory building at several angles to the wind have been completed in the 10-foot wind tunnel. The wind force on a model of a wooden oil derrick has been measured.

Orifice-meter investigations.—In cooperation with the American Gas Association further experiments have been made on natural gas at high pressures and on the effects of pipe size. The Chicago tests of large gas meters with air have been analyzed and a report on them is in preparation.

Heats of combustion of hydrogen, methane, and carbon monoxide.—With a new and improved type of calorimeter the heats of combustion of the above gases have been measured with a high degree of precision. Preliminary values to which certain small corrections have yet to be applied are as follows:

International joules per mol 30° C.	Formation of H_2O	Combustion of CO	Combustion of CH_4
Best value	285,610	282,900	889,600
Number of good observations	18	7	5
Average deviation, per cent	−0.02	0.03	0.03
Maximum deviation, do	−.05	.07	.07
Difference from previously accepted values, do	−.05	−.45	+.75

Properties of steam.—Values have been obtained for the heat content of saturated water from 0° to 270° C., and for latent heat of vaporization and heat content of saturated steam from 100° to 270° C.

Gas analysis.—Several improvements in apparatus for volumetric gas analysis have been developed, including a method of controlling the flow of mercury into the burette, a pipette in which the gas is forced through a perforated platinum plate into the absorbing reagent in the form of very fine bubbles, a compensator with the manometer inclosed to reduce fragility, and improved means for cleaning the contact and opening the compensator to air, a new method of lighting the meniscus to permit greater accuracy in reading volumes, and several details of mounting.

Thermal conductivity of insulating materials at ordinary temperatures.—An important feature of this work is the demonstration that the arrangement of fibers has a very large effect on the insulating value of a mass of packed fibers.

Work in cooperation with the American Society for Testing Materials showed that samples of rubber-graphite compositions are suitable standards for the comparative measurement of the thermal conductivity of electrical insulating materials.

In cooperation with the Celotex Co. the temperature coefficients of conductivity, through the range −30° C. to +80° C., of a number of typical insulating and building materials were determined.

Theory of heat conduction.—A note on the theory of heat conduction, published in the Journal of Research, outlines a method whereby the solution of many problems of steady heat flow with variable conductivity can be obtained directly from the solutions of the same problems with constant conductivity.

Heat transfer through building walls.—Heat transfer through a number of types of walls used for dwelling houses and other small buildings has been measured. The thermal resistances of the various components of completed walls have been determined, so that the insulating value of any particular combination can be calculated.

Properties of petroleum products.—In cooperation with the American Petroleum Institute, measurements have been made of the compressibility and thermal expansion of 14 petroleum oils at pressures 1 to 50 atmospheres and temperatures 0° to 300° C. Practical working tables have been prepared whereby the change in volume of an oil with temperature and pressure may be determined readily with a knowledge of specific gravity and viscosity at standard temperatures.

Oiliness of lubricating oils.—Experiments on the Herschel oiliness machine have confirmed the existence of a finite speed at which there occurs a maximum coefficient of friction. Further studies with this machine have shown an average reduction of 20 per cent in the friction of mineral lubricating oils due to the addition of 2 per cent of fatty acid.

Engine tests of lubricating oils.—Refinements in the methods used for standardizing tests on lubricating oils were made for the Quartermaster Corps of the Army. Engine-operating conditions are automatically recorded throughout the test periods.

Journal-bearing performance.—In cooperation with the American Society of Mechanical Engineers, the effect of the length of the bearing and closeness of fit on friction losses has been determined for a series of 21 different sets of journal bearings.

Cutting fluids.—Scientific analysis of 12,000 returns from 68 of the largest users of cutting fluids showing current machine-shop practice has been completed and reported to the American Society of Mechanical Engineers, as a step in a cooperative program for improving the efficiency of metal-cutting operations.

Wear-resistant alloys.—The behavior of identical materials when subjected to "wear" in a variety of ways has been studied to establish reliable test methods for determining relative wear resistance of metals. The results emphasize the importance of fitting the testing procedure to the conditions of wear in service.

Heat-resisting alloys.—Cooperative work has continued with the American Society for Testing Materials and American Society of Mechanical Engineers in correlating test results obtained by workers in a number of different laboratories on identical metallurgical products. Results of long-time tension tests of metals at high temperatures have been coordinated with similar short-time tests. Data on the suitability of various materials for the construction of apparatus for high-temperature service were published.

Solubility of gases in metals.—The equilibrium relations existing between carbon and oxygen in liquid iron at 1,550° to 1,600° C., and the relation between the carbon and oxygen content of the liquid iron and the composition of an overlying gaseous mixture of CO and CO_2 at a total pressure of 1 atmosphere have been studied using the vacuum-fusion and the "residue" methods of analyses developed by the bureau.

Quenching media for steel.—Sodium silicate—"water glass"—has been used to quench steel. The results indicate that it is a useful quenching medium with a "cooling velocity" intermediate between water and oil.

Abrasion tests for rubber.—Standard abrasion-test methods for rubber have been established involving the development of a standard and easily reproducible comparison compound. In order to check the uniformity of the different lots of standard compound an abrasive track sufficient for several thousand tests without appreciable change has been installed. By maintaining standard test samples at all times for comparison it should be possible to include an abrasion test in several of the Federal specifications where such a test is much needed.

Antioxidants in rubber compounds.—A series of aging tests has been made on rubber compounds containing commercial antioxidants. The results show that under practically every condition to which rubber compounds are ordinarily subjected, these materials retard deterioration, although under some of these conditions the effect is much more pronounced than in others.

Effect of humidity and temperature on the properties of rubber compounds.—In cooperation with the American Chemical Society, an Outline of Standard Laboratory Procedure for the Preparation and Physical Testing of Rubber Samples has been published.

Acid in leather.—The investigation of the effects of sulphuric acid on vegetable-tanned leather shows that leather tanned with one of the catechol tanning materials possesses a high degree of resistance to deterioration by acid, while leather tanned with a pyragallol tanning material shows a low resistance. The influence of the degree of tannage on the deterioration by acid has been studied; and, although the high degree of tannage leathers deteriorate more rapidly the influence of this factor is not as great as the type of tanning material. The rate of deterioration rapidly increases with relative humidities above 80 per cent. Grease content influences deterioration but little even for leathers containing from 10 to 20 per cent of cod oil and tallow. It has been shown that certain leathers take up sulphur groups from polluted atmospheres in sufficient quantities to cause deterioration, thus demonstrating the need for means of preserving leather which was originally satisfactorily made. A laboratory test to determine the hydrolysis of leathers when digested with acid has been devised and the results obtained follow very closely the trends shown in the actual aging tests.

Sole leather.—Chrome leather which has been retanned with vegetable tanning materials will wear from 25 to 75 per cent longer than ordinary vegetable-tanned leather, depending upon the extent of the retannage. Those heavily retanned so as to resemble more nearly vegetable-tanned leather showed the least increase in comparative wear. Further work has been started to determine whether the added durability of heavily retanned leathers may not be obtained more economically by using curried or flexible vegetable leathers.

Specifications and properties of leather.—It has been found that in the case of split leathers the grain portion possesses very little strength since the strength-giving fibers lie in the flesh portion. The failure of many leathers in service is attributed to excessive splitting off of these strength-giving fibers and emphasizes the need of careful attention to splitting on the part of the tanner and shoe manufacturer.

Properties of electrical insulating materials.—It has been found that the electrical properties of rubber slowly change with time when there is a sudden change in temperature or pressure.

Heterogeneity of pyrex glass.—Refractive index measurements on various prisms cut from a pyrex glass disk show that a striated non-optical glass may be very uniform in its average optical density and indicate that such optical measurements may be made with high precision and thus be used to supplement or replace mass-density determinations which have been used almost exclusively when investigating variations in the properties of commercial glasses.

New instrument for testing photographic lenses.—Good progress has been made on the design and construction of a new lens-testing apparatus which, by a series of exposures on a single plate, will give complete information regarding the performance of a photographic lens. This is very important in connection with airplane mapping.

Resolving power and sensitivity of motion-picture film.—Representative developer formulas of the types recently coming into use for reduction of "graininess" of motion-picture films were investigated for their value in spectrography and other scientific uses demanding the optimum combination of resolving power and sensitivity.

It was found that resolving power is not susceptible to any considerable improvement by development methods.

Spectral sensitization of photographic materials.—The spectral sensitization produced by bathing photographic plates with mixtures of two important dyes used for this purpose, pinacyanol and pinaflavol, was investigated. Conditions causing coagulation of the dye bath and changes in relative and absolute effectiveness of the two were determined.

Specific gravity balance.—The development of the improved specific-gravity balance was completed. The new equipment was given a trial in field use, and has been adopted as the official standard by the Natural Gasoline Association of America.

The phase equilibrium diagram for the system Cr_2O_3–SiO_2.—The diagram has been determined and is characterized by complete nonmiscibility of the two components in the liquid state. The melting point of Cr_2O_3 has been determined in an oxidizing atmosphere and found to be 2,140° C., a value materially higher than any previously reported.

Spectrochemical analysis.—Besides numerous spectroscopic tests of metals, alloys, precipitates, etc., researches on the structures of certain spectra have given information as to the lines which may be expected to be most sensitive for this purpose. New descriptions of the spectra of lutecium have made an analysis of their structures possible. This is the first of the 14 rare-earth elements to succumb to this method of analysis.

Atomic structure investigations.—Studies of the photo-electric effect in metal vapors, particularly cæsium vapor, have shown that the sensitivity extends far beyond the range predicted by theory. The mechanism of this anomalous sensitivity is found to involve a photochemical reaction between the atoms which are excited by absorption of light and other atoms, and the constants of these reactions have been studied.

Identifications.—Increased attention has been given to the identification of questioned documents, bullets, and firearms which have been or are to be submitted in evidence in cases in which the United States Government is a party at interest. The testimony of the bureau's experts has been directly responsible for saving the Government very large sums of money.

Thermal resistance of nickel-chromium-iron alloys.—Most of the alloys investigated have been found resistant to heat up to 1,000° C.

Thermal expansion of carboloy.—Data on the thermal expansion of carboloy, a tungsten carbide containing cobalt, have been obtained at various temperatures between 20 and 400° C.

Additional projects.—Progress has also been made on the following investigations: Regularities in spectra, development of a stereoscopic thread gage, refractive changes produced by heat treatment of glass, recombination of ions and electrons, vapor pressure of carbon dioxide, specific volume of carbon dioxide, expansion and compressibility of crude oils saturated with methane, spontaneous generation of heat in materials, measurement of thermal conductivity of metals at high temperatures, specific heats of organic materials at low temperatures, standard methods for testing brake linings, antifreezing liquids for automobile radiators, consistency of plastic

materials, standardization of hardness of grease, fluidity of oils at low temperatures, load-carrying capacity of journal bearings, efficiency of gears, combustion of carbon monoxide, heat capacities of aqueous solutions, factors involved in silver plating, microscopy of organic compounds for identification purposes, development of thermal expansion apparatus, and precision screw cutting and ruling machine.

Research associates.—Table 2 gives the names of associations and manufacturers cooperating with the bureau under the research associate plan, together with the number of associates and the problems on which they are engaged.

TABLE 2.—*Research associates at the Bureau of Standards*

Assigned by—	Number	Specific project
American Association of Textile Chemists and Colorists, W. E. Hadley, secretary, care of Clark Thread Co., Newark, N. J.	1	Assisting in study of methods for testing fastness to light of dyed fabrics.
American Chemical Society, rubber section, Mills Building, Washington, D. C.	1	Physical testing of rubber.
American Dental Association, 58 East Washington Street, Chicago, Ill.	2	Study of dental materials.
American Electric Railway Association, R. H. Dalgleish, president, Capital Traction Co., Washington, D. C.	1	Lubrication of journal bearings.
American Face Brick Association, 130 North Wells Street, Chicago, Ill.	2	Face brick absorption and transverse compression; efflorescence.
American Foundrymen's Association, Cleveland, Ohio	1	Liquid shrinkage in metals.
American Gas Association, 342 Madison Avenue, New York, N. Y.	3	Research on gas; corrosion of pipe lines.
American Institute of Steel Construction, New York, N.Y.	1	Fire tests on battle deck floor construction.
American Petroleum Institute, 250 Park Avenue, New York, N. Y.	8	Properties of petroleum products.
American Society of Mechanical Engineers, 29 West Thirty-ninth Street, New York, N. Y.	7	Steam-table research and high-temperature measurements.
American Society for Testing Materials, 1315 Spruce Street, Philadelphia, Pa.	2	Research in cement; testing.
American Standards Association, 29 West Thirty-ninth Street, New York, N. Y.	3	Development of instruments and methods for testing elevator-safety equipment.
Asphalt Shingle and Roofing Institute, 2 West Forty-fifth Street, New York, N. Y.	1	Relative values of different fibers used in roofing felts.
Associated Knit Underwear Manufacturers of America (Inc.), 329 Main Street, Utica, N. Y.	1	Standardization and simplification of underwear sizes; methods of manufacture.
Atlas Lumnite Cement Co., 25 Broadway, New York, N. Y.	2	Research in cement; testing, etc.
Brown Co., Berlin, N. H.	2	Permanency of paper.
Bunting Brass & Bronze Co., 715–755 Spencer Street, Toledo, Ohio.	2	Testing of bronze.
Bureau of Efficiency, Washington, D. C.	1	Routine testing of paper.
Cast Iron Pipe Research Association, 566 Peoples Gas Building, Chicago, Ill.	1	Investigation of causes of soil corrosion.
Celotex Co., 645 North Michigan Avenue, Chicago, Ill.	1	Heat transfer of building-insulating materials.
Cerro de Pasco Copper Corporation, 44 Wall Street, New York, N. Y.	1	Development of new uses for metallic bismuth.
Committee on Glass, E. C. Sullivan, chairman, Corning Glass Works, Corning, N. Y.	1	Physical properties of glass.
Common Brick Manufacturers of America, 2121 Guarantee Title Building, Cleveland, Ohio.	2	Moisture transmission of brick walls.
Copper and Brass Research Association, 25 Broadway, New York, N. Y.	1	Corrosion of copper roofing materials.
Cooper, Hugh L., Co. (Inc.), 101 Park Avenue, New York, N. Y.	3	Use of clays in concrete mixtures.
Cotton Textile Institute (Inc.), 320 Broadway, New York, N. Y.	1	Study of specific uses for cotton materials.
Dardelet Thread Lock Corporation, 120 Broadway, New York, N. Y.	3	Locking devices for screw threads.
Indiana Limestone Association, Bedford, Ind.	1	Study of physical properties of Bedford limestone.
International Association of Electrotypers, Dan A. Hoynes, 1760 East Twenty-second Street, Cleveland, Ohio.	1	Plating of electrotypes.
Marine Underwriters' Committee, 82 Beaver Street, New York, N. Y.	1	Investigation of spontaneous ignition of jute fibers, etc.

TABLE 2.—*Research associates at the Bureau of Standards*—Continued

Assigned by—	Number	Specific project
Midvale Co., Philadelphia, Pa.	1	Properties of metals at high temperatures.
National Association of Glue Manufacturers, J. R. Powell, secretary, care of Armour Glue Works, 1355 West Thirty-first Street, Chicago, Ill.	1	Use of glue in paper sizing.
National Association of Hosiery and Underwear Manufacturers, 334 Fourth Avenue, New York, N. Y.	2	Study of methods of manufacture of hosiery and knitted goods.
National Lead Co., 105 York Street, Brooklyn, N. Y.	1	Research in pigments.
National Research Council, Washington, D. C.	11	Radio; insulating materials; deterioration of paper; gumming of petroleum; mechanics, etc.
National Terra Cotta Society, 19 West Forty-fourth Street, New York, N. Y.	3	Investigation of architectural terra cotta.
Non-Ferrous Ingot Metal Institute, 308 West Washington Street, Chicago, Ill.	1	Nonferrous ingot metal research.
Portland Cement Association, 111 West Washington, Street, Chicago, Ill.	8	Constitution and hardening of Portland cement.
Society of Automotive Engineers, 29 West Thirty-ninth Street, New York, N. Y.	7	Cooperative fuel research.
E. R. Squibb & Sons Co., New Brunswick, N. J.	2	Investigation of antifreeze mixtures.
Steel & Tubes (Inc.), 224 East One Hundred Thirty-first Street, Cleveland, Ohio.	1	Tension, compression, elongation, deformation, etc., tests of tubes.

TESTING RAILROAD-TRACK AND OTHER SCALES ($48,900)

Calibration of test cars.—Fifty-five calibrations were made on 17 self-contained and 8 compartment-type track scale test weight cars at the master-scale depot at Clearing, Ill. In 17 of the calibrations the cars were found to be heavy and in 38 the cars were found to be light. The average error of self-contained cars was 9.5 pounds and that of compartment-type cars was 58.6 pounds.

Cooperation with industrial technical groups.—The bureau cooperated with the National Scale Men's Association, the National Scale and Balance Manufacturers' Association, and the American Railway Engineering Association in the development of specifications for railway-track scales and test-weight cars.

Formal committee contact has been maintained with the American Railway Engineering Association on matters relating to railway weighing machinery and methods of use.

Master-scale tests.—Sixteen of the 19 master-track scales in the United States were calibrated. One master scale at Reading, Pa., was retired and replaced with a new installation.

Railroad-track scales.—Eight hundred and fifty railroad-track-scale tests were conducted, an increase of about 15 per cent over the preceding year and about 20 per cent over the fiscal year 1928. Of the scales tested 71.8 per cent were within the bureau's tolerance of 0.20 per cent. The average weighing error for the scales tested was 0.21 per cent, or slightly more than the above-cited tolerance. The figures are substantially the same as those for recent years. Scales owned by railroads generally exhibit better weighing performance under test than those owned by industry or commercial organizations. The differences may be ascribed to the fact that the railroads maintain special departments to keep their weighing equipment in proper order.

The comparative standing of the eastern, southern, and western districts with regard to the proportion of correct scales is represented by the respective values, 72.3, 64.4, and 79.3 per cent.

Track scales for weighing grain.—A separate analysis made of test results for 41 track scales in grain-weighing service indicates that on the basis of the 0.10 per cent tolerance, 21 scales, or 51.2 per cent of the total, were correct. For the entire group, the average weighing error was 0.14 per cent. Comparatively few track scales in grain-weighing service even at terminal markets conform to the type specified for this work, whereas in other lines, such as in the "origin" weighing of coal at Great Lakes ports, nearly all scales are of approved-specification type. Out of 27 of such scales tested 85 per cent were correct within the regular tolerance of 0.20 per cent.

Test-car calibrations in field.—The weights of 24 track scale test cars were restandardized for railroads or industries which do not have master-scale facilities.

Track-scale census.—The railways of the country were circularized to secure a revised census of railroad-track scales and the returns will be used in revising the office records and in working up a new map system. The returns indicate that the number of track scales now in use is roughly 25 per cent less than in 1925 when the last census was taken. There are now approximately 3,800 railroad-owned scales and 5,200 industry-owned scales.

Cooperation with States in weights and measures matters.—Formal State conferences were attended in California, Illinois, Maine, Massachusetts, Michigan, New Jersey, New York, Ohio, and Pennsylvania; informal conferences were held with officials in Connecticut, Delaware, Illinois, Indiana, Minnesota, Nebraska, Nevada, New Hampshire, New Jersey, North Dakota, Oregon, Pennsylvania, Utah, Vermont, Washington, Wisconsin, and Wyoming, travel in these cases being largely incident to attendance at formal meetings.

Preparation of a digest of weights and measures court decisions has been continued, and a publication was issued describing equipments in use by officials for the testing of large-capacity scales.

Cooperation with other Government departments.—Frequent consultations have been held with representatives of other Federal departments on weighing or measuring problems and equipment, and numerous weighing and measuring devices have been tested or examined for these agencies, both in Washington and at Clearing.

STANDARDIZATION OF EQUIPMENT ($220,000)

General conferences on simplified practice.—Fifteen general conferences were held to adopt simplified-practice recommendations. Simplified-practice recommendations covering 113 commodities have been approved and adopted by the industries affected, while others are in the process of acceptance. Printed recommendations have been issued for 100 commodities.

Revision and reaffirmation conferences.—Thirty-nine conferences of the standing committees took place to consider the desirability of revising existing simplification programs. Thirty-four recommendations, or 85.3 per cent of the total number reviewed, were reaffirmed, without change, for another year. This compares favorably with the figures for last year, during which 31, or 75.5 per cent, of the 41 recommendations reviewed were reaffirmed.

Adherence to simplified practice recommendations.—Surveys of production, distribution, and use showed that the average adherence to simplified practice recommendations covering 25 commodities was 86.7 per cent. In 1929, the percentage for 26 commodities averaged 85.43.

TABLE 3.—*Degree of adherence determined by actual survey*

S. P. R. No.	Commodity	Degree of adherence	S. P. R. No.	Commodity	Degree of adherence
		Per cent			*Per cent*
1	Paving brick	87.8	55	Tinware, galvanized, and japanned ware	90
2	Bedsteads, springs, and mattresses	91			
4	Asphalt	89.4	62	Metallic cartridges	99
10	Milk bottles and milk-bottle caps	79	63	Metal spools	43
11	Bed blankets	90.5	66	Automobile brake lining	78.9
12	Hollow building tile	89.5	67	Roller bearings	58
13	Structural slate	63.7	68	Metal and fiber flash-light cases	93
14	Roofing slate	94.5	73	1-piece porcelain insulators	91
15	Blackboard slate	95.6	76	Ash handles	89
24	Hospital beds	91.3	77	Hickory handles	80.6
30	Roofing ternes	100	88	Floor sweeps	96.5
31	Loaded paper shot shells	99.5	98	Photographic paper	96.6
43	Paint and varnish brushes	83.7			
49	Sidewalk, floor, and roof lights	98.2		Average	86.7

Variety surveys in progress.—Upon request, 34 preliminary conferences were organized for 32 different industries. In consequence, surveys of existing overdiversification of product were instituted by simplified-practice committees appointed by 16 of those industries. Similar activity is contemplated by the other 16 groups.

Simplified practice and distribution.—Simplification of material-handling equipment and containers in general has recently received attention. A field study of wrapping and packing methods and supplies used in department stores is in progress. Upon request, the bureau has surveyed 34 department stores, located in 17 cities throughout the United States.

Directory of governmental laboratories.—As the result of a request from the War Department, the chief coordinator arranged for the preparation by the bureau of a classified list of all governmental laboratories, facilities, etc., available for the testing of supplies and materials for the purchasing officials of the various governments.

Encyclopedia of specifications.—Manuscript for the second volume of the encyclopedia series, entitled "Standards and Specifications for Nonmetallic Minerals and Their Products," was revised to bring it down to date and will soon be published. This is a companion volume to Standards and Specifications in the Wood-Using Industries, already published, and Standards and Specifications for Metals and Metal Products, the manuscript of which is now in preparation.

Cooperation with public purchasers.—In its compilation of the Encyclopedia and the Directory of Commodity Specifications, and in collecting material for the Standards Yearbook, the bureau has established contacts with more than 25,000 public purchasers.

Facilitating the use of specifications.—In order to facilitate the use of Federal specifications and commercial standards by governmental purchasing agencies, there has been sent to these agencies names and addresses of more than 3,000 "willing-to-certify" manufacturers. The following commodities are now covered: Abrasives

and polishing materials; brick, common; brushes and brooms; builders' hardware; cement, Portland; commercial standards; dental and surgical supplies; electrical supplies; fire extinguishers and liquids; floor coverings; glass; heat-insulating materials; inks; leather goods; lime and plaster; liquid-measuring devices; lumber, softwood; packing and gaskets; padlocks; paints and paint materials; paper; pipe and pipe fittings; refractories; ribbons, typewriter; road and paving materials; roofing, bituminous, and waterproofing; rope, wire; safes, burglar-resisting; scales, railroad track; scales, weighing; screws, wood; soaps and scouring compounds; tableware, silver-plated; textiles; and tubing, metallic.

Commercial standards.—Five general conferences were held, covering the following subjects: Plain mohair-upholstery plush, red-cedar closet linings, plate-glass mirrors, interchangeable ground-glass joints, and feldspar.

A satisfactory majority of acceptances have been received to warrant the success of the following 16 projects: Diamond-core drill fittings, plain and thread plug and ring gage blanks, builders' hardware (nontemplate), builders' template hardware, dress patterns, men's pajamas, foundry patterns of wood, standard screw threads, special screw threads, standard weight malleable iron or steel screwed unions, feldspar, interchangeable ground-glass joints, domestic and industrial fuel oils, hickory golf shafts, wall paper, and staple vitreous-china plumbing fixtures.

The 12 following commercial standards have been issued in printed form: Wrought-iron pipe nipples (CS6–29), standard weight malleable iron or steel screwed unions (CS7–29), builders' template hardware (CS9–29), brass pipe nipples (CS10–29), regain of mercerized cotton yarns (CS11–29), domestic and industrial fuel oils (CS12–29), dress patterns (CS13–30), men's pajamas (CS15–29), wall paper (CS16–29), diamond-core drill fittings (CS17–30), hickory golf shafts (CS18–29), and foundry patterns of wood (CS19–30).

Safety codes.—In cooperation with a committee of national scope, a new edition of the Elevator Safety Code has been prepared. Members of the staff have participated actively in the work of the safety code correlating committee and in sectional committees preparing and revising safety codes for various industries. Revisions of the factory-lighting code and the code for abrasive wheels were completed by such committees. Work was continued on codes dealing with walkway surfaces; conveyors and conveying machinery; cranes, derricks and hoists; mechanical refrigeration; industrial sanitation; mechanical power transmission; and traffic signs and signals. Assistance was given various States in the preparation of local regulations. A survey of accidents in the homes of club women in North Carolina was made as a preliminary to a movement in cooperation with the General Federation of Women's Clubs to reduce accidents in the home.

Heating radiators.—The original program of work on cast-iron tubular-type radiators was completed. This included determinations of effectiveness and heat dissipating ability of the various commercial sizes of radiators of this type. The general conclusion was that the size and style influenced the effectiveness, but not to any great extent. Apparatus was constructed with which to test radiators of the fin-convective type.

Algebraic computation of spherical aberration.—The investigation of algebraic methods for computing the aberrations of lenses has been continued. For spherical aberration a new system of formulas has been developed. These are in a form suitable for use with a computing machine.

Dry-cell standardization.—The qualification tests made primarily in connection with Government purchases have been continued, and have included samples from practically all makers of dry cells in this country. The mechanical equipment for controlling the tests makes it possible to test a large number of batteries with a minimum amount of labor. Results of these tests have served as a basis for a revision of the American Standard for dry cells and also for a revision of the Federal specification.

Specifications for storage batteries.—Automotive storage batteries are now covered by a specification which was completed and ready for transmission to the Federal Specifications Board at the close of the year. Progress has been made in the preparation of a standard specification for sulphuric acid and battery electrolyte.

STANDARD MATERIALS ($10,600)

During the year 7,592 samples were distributed, having a sales value of $16,764, and approximately $73,073 worth of standard samples were added to the salable samples on hand. The standard samples include ores, ceramic and metallurgical products, and pure chemicals, and are used to check methods of chemical analysis that control the manufacture and sale of metallurgical, ceramic, and agricultural products; to calibrate scientific instruments; and to further research in methods of analysis. A direct result of the use of the samples is a saving of thousands of dollars a year through improved manufacturing operations and the avoidance of costly disputes based on faulty analyses. The standard sample fund is unique in that the return to the United States Treasury in fees and accumulated stocks of salable samples has always far exceeded the appropriation.

INVESTIGATION OF RADIOACTIVE SUBSTANCES AND X RAYS ($31,500)

Cosmic radiation.—Certain results of experiments using three Geiger-Mueller tube counters placed vertically one above the other, with a strong magnetic field introduced between the two lower counters, are interpreted as indicating that cosmic radiation consists of electrified particles with velocities corresponding to 10^9 volts accelerating potential.

Development of X-ray standards.—A service for the precise calibration of X-ray dosage meters has been established, and a number of instruments have been calibrated for cancer hospitals.

A portable secondary standard X-ray ionization equipment of weight and volume about one-fifteenth that of the standard equipment has been developed for comparing the standards in this country and abroad—a condition heretofore impossible of attainment with sufficient accuracy.

Study of X-ray generators.—In cooperation with a number of manufacturers an investigation of X-ray equipment, including that in hospitals, is in progress.

Measuring high direct-current potentials of X-ray generators.—Up to the present, the spark gap has been used almost exclusively for this purpose, with inadequate accuracy. An equipment of the voltmeter-multiplier type with an error of only two-hundredths of 1 per cent has been devised, constructed, and found entirely satisfactory for measuring the rippled voltage furnished by X-ray generators.

Radium testing.—Eleven hundred and seventy-three preparations of radium, totaling nearly 10,000 milligrams of the element, and fixing a sale value of about $650,000 were tested; also, 67 samples of luminous material were measured for brightness.

Other investigations.—Progress has also been made on the following investigations: α-ray tracks in various gases; a possible relation between the energy levels and the magnetization of an iron atom; dosage measurement in X-ray therapy; the nature of the action of the Geiger counter; quality determination of X rays; cathode-ray dosimetry; X rays from thin targets; deflection of cathode beams by thin metal foils; functioning of X-ray equipment; and study of mechanism of electrical conduction of rarefied gases.

UTILIZATION OF WASTE PRODUCTS FROM THE LAND ($52,700)

Utilization of cornstalks and wheat straw.—In the manufacture of wall board from cornstalks, new types of machinery have been tried out in a successful effort to find the best-suited equipment for this purpose. Wall board has been made having a thickness of one-half inch and twice as strong as any insulating board on the market. An insulating board 2 inches thick without lamination has been made for use in refrigerators.

From a process developed at the bureau a material called "maizolith" has been produced from cornstalks, which has many characteristics of hard rubber or vulcanized fiber.

The work on the manufacture of paper from straw pulp is being continued in an effort to improve the quality of the paper produced. Samples of pulp have been forwarded to Washington and made into paper and the paper tested. New quarters have been established and new equipment is being installed for the continuation of this work.

Manufacture of xylose.—In cooperation with the University of Alabama, the Alabama Polytechnic Institute, and the Alabama Industrial Development Board, a semicommercial factory was successfully operated at the plant of the Federal Phosphorus Co., Anniston, Ala., for the manufacture of xylose from cottonseed-hull bran, and other raw materials such as peanut shells and corncobs.

By a process developed in the laboratory in Washington, xylose was manufactured at the rate of 100 pounds per day. The crude xylose was given a purification and recrystallization treatment which rendered it 99.99 per cent pure.

Samples of xylose have been forwarded to individuals and concerns all over the world who are cooperating in the investigation of

its possible use in the dyeing and tanning industries, in foodstuffs, in explosives, for manufacture of chemicals, of alcohol to be used as solvent for lacquer, etc.

Miscellaneous.—A preliminary investigation of artichoke tops was conducted and a very good grade of board was obtained therefrom. The utilization of sugars from the waste products of corn was studied as well as the separation of glycosides by means of calcium chloride addition compounds.

INVESTIGATION OF AUTOMOTIVE ENGINES ($26,500)

Automobile-engine acceleration.—From tests made in cooperation with the American Petroleum Institute, the National Automobile Chamber of Commerce, and the Society of Automotive Engineers with the portable spark accelerometer on a number of representative automobile engines at the laboratories of the companies manufacturing them, it was concluded that the effect on acceleration of fuel volatility is qualitatively independent of engine design.

Antiknock characteristics of fuels.—To secure uniformity in expressing antiknock value, the subcommittee on methods of measuring detonation, appointed by the cooperative fuel-research steering committee with which the bureau is cooperating, has recommended that all laboratories be invited to express their present knock-rating scales in terms of octane numbers. The octane number of a gasoline is defined as the number of parts by volume of iso-octane that must be added to 10 parts of normal heptane to produce a blend of equivalent detonation characteristics.

The antiknock investigation is now the major problem of the joint motor-fuel research supported cooperatively by the American Petroleum Institute and the National Automobile Chamber of Commerce through the Society of Automotive Engineers.

Vapor lock in airplane fuel systems.—It has been found that for gasoline which does not contain appreciable amounts of propane the vapor-locking temperature is equal at sea level to the American Society for Testing Materials 10 per cent point and decreases about 2° F. for each 1,000 feet altitude. The effect of weathering of the gasoline on the vapor-locking tendency has also been studied. Data on temperatures which exist in fuel lines during flight are being secured through cooperation with the Army, the Navy, and the National Advisory Committee for Aeronautics.

Gumming characteristics of gasoline.—Gum in gasolines may cause objectionable deposits in the intake manifold and on the intake valves. The bureau is making a study of the gumming characteristics of gasolines on behalf of the Army Air Corps. New methods of test are being developed since the present procedure is not satisfactory.

Phenomena of combustion.—Upward of 3,000 photographic records of the progress of the gaseous explosive reaction as it occurs at constant pressure in a soap bubble used as a bomb have been analyzed to determine the effect of pressure on the rate of the reaction. The experimental data show that for a charge of given

proportions the linear rate of propagation of the reaction zone within the explosive gases is constant and independent of pressure, and that as a result the rate of molecular transformation is proportional to pressure.

Combustion in an engine cylinder.—Equipment for making stroboscopic observations of flame movement and simultaneous measurements of pressure development in an engine cylinder has been used to obtain diagrams showing the movement of the flame in all parts of the combustion chamber and the variation of pressure during burning. Such data correlate the more fundamental studies of the gaseous explosive reaction at constant pressure with actual engine performance. The work is in cooperation with the National Advisory Committee for Aeronautics.

Supercharging of aircraft engines.—Altitude chamber performance tests of a Curtiss D–12 engine equipped with a Roots-type supercharger, having a critical altitude of 5,000 feet at 2,000 revolutions per minute, were made for the Army Air Corps, and tests with a geared centrifugal supercharger are in progress.

Oil recommendations.—A statistical study has been made of the various grades of oil recommended by the automotive vehicle manufacturers and oil refiners for about 200 makes of trucks, tractors, and passenger cars and the results summarized in convenient form for practical use and published by the Chief Coordinator.

Miscellaneous.—Work on the following projects is under way: Standard tests for fuels for automotive engines, tests of fuel volatility, tests of miscellaneous devices for automotive transportation, and motor-vehicle tax ratings.

INVESTIGATION OF DENTAL MATERIALS ($5,300)

Government purchases of dental golds, amalgam, alloys, etc., having an estimated value of $100,000, have been tested. About half this amount has been rejected as unfit for use in service. Replacements have been made and approved. Specifications have been prepared for dental investments and a thorough test made of all investments on the market. Assistance has been given dental schools, manufacturers, and testing laboratories interested in equipping for this type of research. Lectures and clinics have been given in Washington, New York, Boston, Des Moines, Chicago, and Columbus.

One of the most satisfactory aspects of this program is the move by a number of manufacturers to guarantee certain of their products to comply with the specifications adopted by the American Dental Association, through cooperation with the bureau.

POWER-PLANT EQUIPMENT ($100,000)

The boiler-room equipment was completed and that section of the plant was put in full operation at the beginning of the heating season. The principal units of permanent equipment in the engine-room section of the plant have been installed and will be put in operation within a short time.

TRANSFERRED FUNDS ($436,387)

Organization and projects.—During the year funds were transferred from the following branches of the Government covering the projects listed:

Aeronautics Branch, Department of Commerce
- Air-navigation aids.
- Aeronautical research.

Bureau of Engraving and Printing:
- Electrodeposition.
- Paper currency and stamps.

Coast and Geodetic Survey: Making of special castings.

Coast Guard: Development of radio-receiving sets.

National Advisory Committee for Aeronautics:
- Aerodynamic problems.
- Embrittlement of duralumin.
- Duralumin and steel tubes.
- Aeronautic power plants.
- Substitutes for parachute silks.

Navy Department:
- Airship girders.
- Aircraft instruments.
- Gas-cell fabrics.
- Carbon and chrome steel.
- Corrosion investigation.
- Aeronautic fabrics.
- Airplane ignition systems.

Navy Department—Continued.
- Humidity research.
- Battery testing.
- Submarine storage batteries.
- Production of optical glass.

Post Office Department: Development of accelerometers.

Steamboat Inspection Service: Fire-alarm systems.

United States Shipping Board:
- Studies of petroleum.
- Miscellaneous engineering and physical investigations.
- Miscellaneous chemical investigations.

War Department:
- Gasoline investigation.
- Superchargers for aircraft engines.
- Embrittlement of duralumin.
- Radio apparatus for signal service.
- Friction and lubrication studies.
- Substitutes for leather.
- Substitutes for chromium.
- Nontin metal.
- Experimental gages.
- Development of machine guns.

Many of these projects were supported partly by bureau and partly by transferred funds. The more important of these have already been described under the appropriate bureau fund. Important investigations supported wholly by transferred funds include the following:

Air-navigation facilities—Radio.—In cooperation with the Aeronautics Branch, experimental work on the 2, 4, and 12 course visual-type radiobeacons was completed. The sensitivity of the vibrating-reed indicator was increased fourfold. The development of a new transmitter for the simultaneous transmission of radiotelephone messages and visual-type radiobeacon signals on the same radio-frequency was begun. An automatic volume-control device for use in the reception of visual beacon signals was developed, thereby relieving the pilot of the duty of controlling the receiving-set sensitivity. A complete system of radio aids showing good promise for blind landing of aircraft was developed.

Contact and cooperation with the aircraft and radio industries in the development of engine ignition shielding was maintained. A commercial shielding assembly patterned after an assembly developed by this bureau met with marked success. A direction finder permitting aural or visual indication of the direction of the received signal was developed.

Lighting of airports and airways.—Photometric measurements have been made on 24-inch beacons, code beacons, and gaseous-discharge tube beacons, and observations of their visibility have been made from fixed stations and from airplanes. Observations on several types of boundary lights have been made from two distances

by 16 observers. Experiments on the lighting of wind-indicator cones have been continued, and measurements are in progress on aviation red and green signal glasses, for the purpose of preparing specifications.

Radio-receiving sets for the Coast Guard.—Apparatus was purchased and developed suitable for determining the electrical sensitivity, selectivity, fidelity, and overload characteristics of radio-receiving sets. The sets tested include 9 submitted as bid samples to the Coast Guard, 3 high-frequency sets for the Navy, 1 intermediate-frequency set for the Bureau of Lighthouses, 4 aircraft radio sets for the aeronautic research division, and 1 set purchased by this bureau.

Corrosion of storage-battery plates.—Corrosion of the positive plates in certain submarine batteries has led to a study of the effects of organic material and the conditions under which corrosion of the plates may occur. Conflicting evidence on the effect of acetic acid in storage batteries has been explained, and a method for the determination of small amounts of acetic acid in the presence of large amounts of sulphuric acid has been developed.

Type testing of commercial airplane engines.—The engine-testing laboratory at Arlington is operating at full capacity and a fourth torque-stand unit will be added to provide for probable increased demands. Of 52 engines received for test during the year 26 passed, 23 failed, and 3 were withdrawn. This work is supported by the Aeronautics Branch of the Department of Commerce.

Effect of spark character on ignition ability.—In cooperation with the National Advisory Committee for Aeronautics and the Bureau of Aeronautics of the Navy Department, the relative effectiveness of ignition sparks has been compared by determining the amount of chemical reaction which takes place when different sparks are passed through an explosive mixture of oxygen and hydrogen at low pressure and liquid-air temperature.

Effect of air humidity on engine performance.—An improved form of psychrometer has been developed as a by-product of this work, which is in cooperation with the Navy Department; action to obtain a Government patent will be initiated.

Engine power tests have been made, extending the range of humidity from 1 to 80 millimeters mercury pressure of water vapor. These tests accord with the oxygen-content hypothesis. Results indicate an increase in effectiveness of tetraethyl lead as a knock suppressor at increased humidities. Especial attention was given to the possibility of changes of humidity causing error in knock rating.

Aircraft-instrument developments.—A strut thermometer of the electric-resistance type, an improved suspended-head air-speed meter of the commutator-condenser type, and a maximum indicating accelerometer were constructed for the Bureau of Aeronautics, Navy Department. A mooring-force indicator for the airship *Los Angeles* and a suspended Pitot static-head air-speed meter are under development. Investigations to provide a basis for the specification of performance of banking indicators, magnetic compasses, and tachometers were conducted. A standard vibration board was designed and constructed for the purpose of testing aircraft instruments.

Reduction of noise in airplanes.—In cooperation with the Aeronautics Branch of the Department of Commerce, studies have been made of the possibilities of reducing noise in airplanes.

Aileron investigation.—In cooperation with the National Advisory Committee for Aeronautics and the Aeronautics Branch of the Department of Commerce, the effect of variation of chord and span of ailerons on rolling and yawing moments at high angles of attack has been studied.

High-speed airfoil tests.—In cooperation with the National Advisory Committee for Aeronautics, the aerodynamic characteristics of eight airfoils of circular-arc section were determined at speeds up to and slightly above the speed of sound. These airfoils are more efficient at high air speeds than ones of conventional type, and are therefore of advantage in designing high-speed propellers.

Investigations of wind-tunnel turbulence.—In cooperation with the National Advisory Committee for Aeronautics the significance of measurements with the hot-wire anemometer has been investigated by studying the transition from laminar to eddying flow around a thin flat plate parallel to the wind.

High-frequency fatigue testing.—In cooperation with the National Advisory Committee for Aeronautics, seven air-driven, high-frequency fatigue machines are now operating at frequencies of approximately 200 cycles per second. Each test bar is subjected to 200,000,000 cycles of stress if failure does not occur before this limit is reached.

Flat plates under normal pressure.—At the request of the Navy Department, an apparatus was designed and built for testing specimens representing pontoon construction by subjecting them to a normal water pressure.

Strength of welded aircraft joints.—To assist the Aeronautics Branch of the Department of Commerce, the strength and efficiency of 40 types of acetylene-welded fuselage joints made of chrome-molybdenum steel tubing were determined. The use of gusset plates welded to the tubes increased the strength about 30 per cent in the case of some types of joints.

Distinguishing steel airplane tubing of different compositions.—Preliminary work with the Bureau of Aeronautics and the National Advisory Committee for Aeronautics indicates that a magnetic test and a spark test may give satisfactory results as rapid nondestructive methods for distinguishing between plain carbon and chrome-molybdenum steel tubing. A simple chemical "spot test" appears to be impossible.

Prevention of embrittlement of sheet duralumin by corrosion and of deterioration of magnesium alloys by corrosion.—Results of 3-year exposure tests closely confirm laboratory tests in showing the superiority of pure aluminum as a coating material for duralumin and of the necessity of proper heat treatment if maximum corrosion resistance is to be obtained. Laboratory tests have shown the decided advantage gained in coating aluminum alloys by giving the surface a preliminary treatment by the anodic oxidation process. Experiments show that coating magnesium-alloy specimens to resist atmospheric corrosion is a more serious problem than in the case of aluminum alloys.

Bearing alloys.—In cooperation with the War Department, a study has been started of lead-base and tin-base bearing alloys for Army trucks. The work will be extended to include the copper-lead bearing materials.

ACKNOWLEDGMENTS AND RECOMMENDATIONS

The Congress has recognized the need of several projects recommended in previous reports by making due provisions and appropriations. Thus, the regular appropriations for 1931 contain increases over 1930 for salaries, grounds, structural materials, mechanical appliances, textiles, sugar, gages, metallurgy, industrial research, standardization of equipment, automotive engines, railroad scales, and dental materials, totaling $263,925. Appropriations for new projects in 1931 include $350,000 for the hydraulic laboratory, $75,000 for addition to the shops building, and $400,000 for additional land. Provision was also made for stationing a medical officer of the Public Health Service at the bureau to eliminate health hazards in certain lines of work and care for emergency-accident cases.

Radio stations.—There is pending in the Senate an authorization which has passed the House, making provision for two radio stations at locations removed from extraneous influences. These stations are needed (1) for transmitting continuously standard signals to enable broadcasting stations to check at will their wave lengths and (2) for experimental purposes, particularly with reference to short-wave phenomena.

New buildings.—The present buildings of the bureau are greatly overcrowded, and it is urgently recommended that adequate provision be made for expansion. The most urgent need is for an administration building, costing about $400,000, which would free certain spaces greatly needed in laboratory buildings as well as providing adequate accommodations for the rapidly expanding work of the standardization group and also for the administrative and other general functions of the bureau, including library and conference rooms.

Provision has been made for additional space in Federal buildings at San Francisco and Denver.

There has been previously submitted a 5-year building program, which includes provision for a high-voltage laboratory, fire-resistance laboratory, extension of the dynamometer laboratory, an enlarged low-temperature laboratory, and new laboratories for mechanical engineering and high-precision testing in weights and measures.

As the demands for the bureau's services grow, provision should be made, in Washington and the branch laboratories, to meet these needs by increasing the facilities and personnel engaged in research and testing.

Very truly yours,

GEORGE K. BURGESS,
Director, Bureau of Standards.

BUREAU OF FISHERIES

DEPARTMENT OF COMMERCE,
BUREAU OF FISHERIES,
Washington, July 1, 1930.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: I have the honor to submit the following report of the operations of the Bureau of Fisheries during the fiscal year ended June 30, 1930.

There is much evidence of an intensified interest in the future welfare of our fisheries. Sportsmen's organizations are concentrating their efforts to provide better angling, to overcome the evils of pollution, and to obtain the passage of State and Federal laws which will more adequately conserve this great natural resource. Commercial fishermen are taking a greater harvest from the waters than ever before, are introducing greatly improved methods, and are revealing a greater interest in the proper conservation of this resource as a sound economic policy. State governments are giving more and more attention to legislation affecting the fisheries, and State executives are revealing greater interest in the selection of capable administrators in their departments of conservation. The State Department has negotiated with Canada a revised convention for the preservation of the halibut fishery of the North Pacific Ocean and a convention for the preservation and extension of the sockeye salmon fisheries breeding in the Fraser River system, which now await ratification by the Senate. Greater cooperation is requested from the bureau by other Federal agencies in the heavier stocking of the waterways on public lands with game fish and in working out a stream-stocking policy to insure good fishing to the millions of our people who visit our national parks and forests annually. Congress has also revealed a greater interest in fishery problems in the passage of a 5-year construction and maintenance program for the Bureau of Fisheries, an amended black-bass law of much broader power, provision for the study of the probable effect on the fisheries of the proposed power project in Passamaquoddy Bay, and by the Senate's action in creating a special committee on the wild life resources of the country.

The Bureau of Fisheries finds a reflection of this intensified interest in the increased demands for fish for stocking waters, for additional fish-cultural facilities, and aid to a greater number of private organizations interested in the cooperative rearing of fish for stocking local streams. This is also true of the demands for scientific investigations to disclose the need of stronger conservation measures; for studies of every important fishery to reveal its condition and trend; for an expansion of its investigative program with respect to such aquicultural pursuits as oyster farming, fish farming, and the control and prevention of diseases. Likewise more intelligent interest is being shown in the solution of the problems of the commercial fisheries, improvements in methods of manufacturing and merchandising, in the

use of by-products, and in the conduct of fundamental investigations with respect to processes, nutrition, and uses.

The success of the bureau's efforts in rehabilitating the fur-seal herd breeding on the Pribilof Islands, from 130,000 animals to 1,000,000 in less than 20 years, and in saving the important Alaskan salmon runs from exhaustion has received much favorable comment. For the first time in 40 years the killings of fur seals on the Pribilofs in 1929 exceeded 40,000 animals.

The output of the bureau's fish-cultural service in the stocking of streams exceeded 7,570,000,000 fish and eggs as compared with 7,060,000,000 in 1929.

The commercial fisheries of the United States and Alaska are in a sound economic condition. They furnish employment to more than 125,000 commercial fishermen and 4,000 persons engaged in the transportation of the catch. The annual harvest is in excess of 3,000,000,000 pounds, for which the fishermen receive $116,000,000. Edible fishery products constitute over 2,600,000,000 pounds for sale in the fresh state or for manufacture. In the fresh-fish trade of 1929, 84,397,000 pounds were prepared in packaged form valued at $14,813,000, and 121,543,000 pounds of fishery products were frozen. In the canning trade—the most important process of manufacture—the pack amounted to 689,447,000 pounds, valued at $101,065,000. The output of cured and smoked fishery products is estimated at 150,000,000 pounds valued at $12,000,000, and the output of fishery by-products was valued at $23,768,000. This included fish oil, meal, lime and grit from oyster shells, buttons from fresh-water mussel shells, and many other products. Imports of fishery products were valued at $66,566,000 and exports at $23,830,000. In 1929 as compared with 1928 there were substantial increases in the output of packaged and frozen fish, canned fishery products, by-products, imports, and exports.

INTERNATIONAL RELATIONS

NORTH PACIFIC HALIBUT CONVENTION

The International Fisheries Commission provided for under this convention has issued two reports on its work. The first entitled "Report of the International Fisheries Commission Appointed under the Northern Pacific Halibut Treaty" (Bureau of Fisheries Document No. 1073) contains various recommendations which are believed necessary for the saving of this great fishery. The second report entitled "Life History of the Pacific Halibut: (1) Marking Experiments" was published in Canada and is available only through the commission.

The results of the commission's investigations reveal that the abundance of fish on the older halibut banks is now only one-sixth of that 20 years ago. Indications are that the decline in abundance on the newer banks continues at a rapid rate, and on the older banks the stock is at the minimum level upon which the fleet can exist. In fact in places the vessels are now dependent upon other less desirable species. Marking experiments indicate that on the British Columbia banks 40 per cent of the stock of commercial sizes is removed yearly. The residual immature population migrates but little and only by a random scattering movement, averaging less than 20 miles for the period between tagging and recapture. A much smaller percentage of

the large mature fish of the Alaskan banks is caught annually. These migrate along the coast of the Alaskan Peninsula, averaging about 200 miles between tagging and recovery. These studies demonstrate the independence of the stocks of market fish on the Alaskan banks from the Canadian banks and support the previous recommendations of the commission.

To ascertain the spawning grounds, the abundance and direction of drift of eggs and larvæ, and the source of supply of fish populating the various banks and their interdependence, it has become necessary to make a series of tow-net hauls. During the early part of 1929 a large series of such hauls were made in the Gulf of Alaska and between Cape Flattery and Dixon Entrance, especially on the Goose Island grounds. In 1930 other series of hauls were made in Hecate Strait and Dixon Entrance and off the coast of Queen Charlotte Islands. A study of the first series in the Gulf of Alaska indicates the presence of larvæ well out in the gulf, although they were much less abundant than they were along the edge of the continental slope of the Alaskan coast. Hauls made in May along the Canadian waters were much too early to reveal the possible influx of larval fish from Alaskan waters and later more extensive collections became a necessity.

Because of the inadequacy of the existing convention as revealed by the commission's investigations and the urgent need for putting the commission's recommendations into effect, negotiations for a new convention were initiated, and on May 9, 1930, a revised convention was signed at Ottawa. When ratified by the United States Senate this will supplant the convention concluded March 2, 1923.

SOCKEYE SALMON CONVENTION

For many years efforts have been made to work out arrangements for the rehabilitation of the sockeye salmon run of the Fraser River system, British Columbia, through the medium of an international convention with Canada. The convention signed on March 27, 1929, referred to in the last annual report, was subsequently withdrawn and another convention, which has for its purposes the protection, preservation, and the extension of this fishery, was signed on May 26, 1930. The convention covers the sockeye-salmon fishery in the waters contiguous to the State of Washington and the Province of British Columbia, the territorial waters off the coasts of Washington and British Columbia, and the high seas adjacent thereto—the waters covered being defined in the convention. The International Fisheries Commission of six members, provided for in the convention, is charged with the duty of making a thorough investigation into the natural history of the sockeye salmon. It is authorized to construct and maintain hatcheries, and is empowered to prescribe the size of mesh of the gear used. The convention is concluded for a period of 16 years, after which it is subject to termination on notice of 1 year given by either Government.

In 1913 the pack of sockeye salmon in Puget Sound was 1,673,099 cases and in the Fraser River area the pack of Canada was 684,596 cases, making a total of 2,357,695 cases. In 1929 the pack was only 111,898 and 60,393 cases, respectively, making a total of 172,291 cases. The prompt ratification of this convention is important to permit of international cooperation in the rehabilitation of this very important fishery.

PASSAMAQUODDY POWER PROJECT

The proposed damming of Passamaquoddy and Cobscook Bays to develop hydroelectric power may adversely affect the fisheries of the Bay of Fundy and the coast of Maine. A subcommittee of the North American Committee on Fishery Investigations reported on December 12, 1928, as follows:

1. That in its opinion if the proposed construction is carried out, the weir fisheries for herring inside the dams will be almost wholly eliminated.
2. That it is recognized that the effects on the fisheries outside the dams, predicted in the report on the subject presented by Doctor Huntsman, may follow, but the committee as a whole is not prepared to forecast whether these results will or will not follow, believing that a fuller investigation is necessary.

It is agreed that the peculiar hydrographic conditions in the vicinity of Passamaquoddy Bay result in the upwelling of deep water from the Gulf of Maine, bringing with it abundant stores of dissolved chemicals necessary for the production of a wealth of plant and animal life which are the basic food supply of fish. The abundance of these microscopic forms is believed to be responsible for the remarkable concentration of the herring and pollock fisheries in Charlotte County, New Brunswick, and the adjacent coast of Maine. There are grounds for belief that the installation of the proposed dams may so change natural oceanographic circulation as to materially reduce the production of fish food and influence the spawning of the herring and thus may have an important effect on these fisheries.

In 1928 the catch of fish in the general region which may be affected amounted to 190,000,000 pounds valued at nearly $5,000,000. Of the total, 130,000,000 pounds were herring and 10,000,000 pounds pollock.

On September 20, 1929, the Canadian Government proposed an investigation by the joint efforts of the two Governments, requiring at least two years of field observations at an estimated cost of $45,000 per annum.

An appropriation of $22,500 for meeting the United States share of expenses for the fiscal year beginning July 1, 1930, was made by Congress.

INTERNATIONAL FUR TRADE EXHIBITION AND CONGRESS AT LEIPZIG

A joint resolution of Congress approved March 21, 1930, authorized participation by the Government of the United States in the International Fur Trade Exhibition and Congress held in Leipzig, Germany, in 1930. An appropriation of $30,000 was granted for the preparation, transportation, and demonstration of an exhibit portraying the development of the fur industry in the United States and the production, conservation, and utilization of fur as a natural resource.

The joint display of the Department of Agriculture and the Department of Commerce was a modern presentation of fur resources and conservation measures and compared favorably with showings by other nations. The display of the Department of Commerce had to do chiefly with the fur-seal activities of the Pribilof Islands, as administered through the Bureau of Fisheries, and included mounted fur seals and blue foxes, fur-seal skins, an allegorical presentation showing how international cooperation saved the Alaskan fur-seal herd from

extinction, lantern slides automatically shown, colored transparencies, and motion pictures. Appropriate descriptive literature, printed both in English and German, was prepared for distribution to interested persons.

It is felt that the exhibit and congress have been of genuine benefit in stimulating interest in the fur resources of the United States.

DOMESTIC RELATIONS

FIVE-YEAR CONSTRUCTION AND MAINTENANCE PROGRAM

For several years there has been strong support of a measure sponsored by Congressman White, of Maine, chairman of the Merchant Marine and Fisheries Committee, to provide a 5-year construction and maintenance program for the bureau. Such an act was approved May 21, 1930 (Public, No. 240, 71st Cong., H. R. 7405). This act authorizes additional appropriations for new fish-cultural stations and substations, three new laboratories, and two new distribution cars, to the amount of $1,885,000. It also authorizes annual increases in the appropriation for the division of fish culture of $100,000 for the 5-year period and increases in present appropriations for the divisions of scientific inquiry and fishery industries by not to exceed $300,000 and $175,000 per annum, respectively. Under the provisions of the act the bureau may cooperate with States, counties, municipalities, individuals, and public and private agencies, organizations, and institutions, and may accept donations of lands, funds, and other aid to the development of this program. The provisions for an orderly development of its fish-cultural and other agencies will have a far-reaching effect in placing the bureau in position to meet the demands made upon it, and the provisions for increased personnel will be extremely helpful in building up a staff of experts capable of coping with the situation.

The act follows:

[PUBLIC—NO. 240—71ST CONGRESS]

[H. R. 7405]

An Act To provide for a five-year construction and maintenance program for the United States Bureau of Fisheries

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there are hereby authorized to be appropriated during the fiscal year beginning July 1, 1930, such amounts as may be necessary for—

(1) The establishment of a fish-cultural station in each of the following States, at a cost not to exceed the amount specified: New Mexico, $50,000; Louisiana, $50,000; Idaho, $60,000.

(2) The establishment of a fish-cultural substation in each of the following States, at a cost not to exceed the amount specified: Wisconsin (in the southern part of the State), $50,000; Montana, $35,000; Colorado, $35,000; New Hampshire (in the White Mountain Forest), $25,000.

(3) The establishment of a fishery laboratory in the State of Washington, at a cost not to exceed $125,000.

(4) The establishment of experimental and bass and trout stations in the State of Maryland or West Virginia at a cost not to exceed $75,000.

SEC. 2. There are hereby authorized to be appropriated during the fiscal year beginning July 1, 1931, such amounts as may be necessary for—

(1) The establishment of a fish-cultural station in each of the following States, at a cost not to exceed the amount specified: Alabama, $50,000; Indiana, $50,000; Tennessee (in the middle division of the State), $50,000; Pennsylvania (including a substation), $100,000.

(2) The establishment of a fish-cultural substation in each of the following States, at a cost not to exceed the amount specified: South Carolina, or the enlargement of Orangeburg Station in said State, $25,000; Texas (in the western part of the State), $35,000; New York, $35,000.

(3) The purchase of Mill Creek station in the State of California, at a cost not to exceed $20,000.

(4) The purchase and repair of the Rogue River substation in the State of Oregon, at a cost not to exceed $35,000.

SEC. 3. There are hereby authorized to be appropriated during the fiscal year beginning July 1, 1932, such amounts as may be necessary for—

(1) The establishment of a fish-cultural station in the State of Florida, at a cost not to exceed $60,000.

(2) The establishment of a fish-cultural substation in each of the following States, at a cost not to exceed the amount specified: Maine (including enlargement of Craig Brook station), $50,000; Virginia (in the eastern part of the State), $75,000; Minnesota, $50,000.

(3) The establishment of a fishery laboratory in the State of Texas (on the Gulf coast of the eastern part of the State), at a cost not to exceed $75,000.

(4) The purchase or construction of a steel fish-distribution car, at a cost not to exceed $75,000.

SEC. 4. There are hereby authorized to be appropriated during the fiscal year beginning July 1, 1933, such amounts as may be necessary for—

(1) The establishment of a fish-cultural station in each of the following States, at a cost not to exceed the amount specified: Nevada, $60,000; Illinois, $75,000; New Jersey, $75,000; a fish cultural substation in Mississippi (in the southern part of the State), $50,000.

(2) The purchase or construction of a steel fish-distribution car at a cost not to exceed $75,000.

SEC. 5. There are hereby authorized to be appropriated during the fiscal year beginning July 1, 1934, such amounts as may be necessary for—

(1) The establishment of a fish-cultural substation in each of the following States, at a cost not to exceed the amount specified: Ohio, $35,000; Kansas, $35,000; North Dakota, $35,000; Georgia, $35,000.

(2) The purchase and repair of the Little White Salmon station in the State of Washington, at a cost not to exceed $35,000.

(3) The establishment of a fishery laboratory in the Territory of Alaska, at a cost not to exceed $50,000.

(4) The establishment of an experimental and bass and trout station in the Pisgah National Forest or in the Great Smoky National Park in the State of North Carolina upon the acquisition of said park by the United States, at a cost not to exceed $35,000.

SEC. 6. (a) The stations, substations, and laboratories authorized by sections 1, 2, 3, 4, and 5 shall be located in the States and parts thereof and in the Territory specified, at such suitable points as may be selected by the Secretary of Commerce.

(b) Any appropriation made under authority of sections 1, 2, 3, 4, and 5 may be expended for the purchase of sites, and the purchase of equipment, the construction of buildings and ponds, and for such other expenses as may be incidental to the cost of the establishment, purchase, or enlargement, as the case may be, of the station, substation, or laboratory in question.

(c) No part of an appropriation made under authority of sections 1, 2, 3, 4, or 5 shall be expended in the construction, purchase, or enlargement of a station or substation until the State in which such station or substation is to be located shall have by legislative action accorded to the United States Commissioner of Fisheries and his duly authorized agents the right to conduct fish hatching and fish culture and all operations connected therewith in any manner and at any time that may by the commissioner be considered necessary and proper, any laws of the State to the contrary notwithstanding. The operation of any station, substation, or laboratory established, purchased, or enlarged under authority of this Act shall be discontinued whenever the State ceases to accord such right; and such operation may be suspended by the Secretary of Commerce whenever in his judgment State laws or regulations affecting fishes cultivated are allowed to remain so inadequate as to impair the efficiency of such station, substation, or laboratory.

(d) That the authorizations herein given in sections 1, 2, 3, 4, and 5 with reference to appropriations for certain specified years are for the purpose of indicating priority proposed to be given the various projects enumerated therein, but shall not be held to require the appropriations therein enumerated to be made in the years specified, and the appropriations enumerated are likewise authorized in prior or subsequent years in annual or supplemental appropriation Acts.

SEC. 7. There are hereby authorized to be appropriated, in addition to all other amounts authorized by law to be appropriated, not to exceed the following amounts during the fiscal years specified:

(1) For the purpose of providing adequate maintenance costs and personnel for the Division of Fish Culture, Bureau of Fisheries: Fiscal year beginning July 1, 1930, $100,000; fiscal year beginning July 1, 1931, $200,000; fiscal year beginning July 1, 1932, $300,000; fiscal year beginning July 1, 1933, $400,000; fiscal year beginning July 1, 1934, $500,000. Of each amount authorized by this paragraph to be appropriated, not more than 30 per centum is authorized for salaries at the seat of government and elsewhere.

(2) To meet the demand for fundamental knowledge regarding our great commercial fisheries and for developing the natural cultivation of oysters, mussels, and other mollusca, and the improvement of pond cultural, the encouragement of fish conservation in the waters of the Great Lakes and other waters, and other operations of the Division of Inquiry, Bureau of Fisheries, respecting food fishes, sufficient annual additions to increase present appropriations by not to exceed $300,000 per annum at the conclusion of the construction program authorized in this Act. Of each amount authorized by this paragraph to be appropriated not more than 40 per centum is authorized for salaries at the seat of government and elsewhere, and not to exceed $10,000 in any year for a survey of the fisheries of the Hawaiian Islands.

(3) To provide for the proper husbandry of our fisheries, improvements in methods of capture, merchandising, and distribution of our fishery harvest, including saving and utilization of waste products, and other operations of the Division of Fishery Industries, Bureau of Fisheries, sufficient annual additions to increase present appropriations by not to exceed $175,000 per annum at the conclusion of the construction program authorized in this Act. Of each amount authorized by this paragraph to be appropriated not more than 40 per centum is authorized for salaries at the seat of government and elsewhere.

SEC. 8. In carrying out the provisions of this Act the Bureau of Fisheries may cooperate with States, counties, municipalities, individuals, and public and private agencies, organizations, and institutions, and may accept donations of lands, funds, and other aid to the development of this program.

Approved, May 21, 1930.

BLACK-BASS LEGISLATION

The act of May 20, 1926, designed to regulate the interstate transportation of black bass, proved to be impracticable of enforcement. During the second session of the Seventy-first Congress, at the request of a congressional committee, the bureau made a careful study of the subject and aided in drafting a comprehensive corrective measure which was adopted by the Congress at the close of the fiscal year. This act will be effective on and after July 2, 1930. The act, among other things, provides in substance that it shall be unlawful for any person to deliver or knowingly receive for transportation, or knowingly to transport, any black bass, if (1) such transportation is contrary to the law of the State from which such black bass is or is to be transported, or (2) such black bass has been either caught, killed, taken, sold, purchased, possessed, or transported, at any time, contrary to the law of the State in which it was caught, killed, taken, sold, purchased, or possessed, or from which it was transported; and that no person shall knowingly purchase or receive any such black bass which has been transported in violation of the act.

The act also provides that all interstate shipments of black bass shall be clearly and conspicuously marked and show the names and

addresses of the shipper and consignee; that all black bass transported into a State in interstate commerce shall be subject to the operation and effect of the laws of that State to the same extent and in the same manner as though the fish had been produced in such State, and shall not be exempt therefrom by reason of having been introduced therein in original packages or otherwise; and makes provision for the confiscation of illegal shipments of black bass, not only on conviction of the offender but upon the judgment of the court that the same were delivered, transported, purchased, or received in violation of the act.

Authority to enforce the act and to make such regulations as may be necessary to carry out its purposes is vested in the Secretary of Commerce. As soon as funds are provided by Congress steps will be taken to carry out the provisions of the act. A copy of the act follows.

[PUBLIC—No. 495—71ST CONGRESS]

[S. 941]

An Act To amend the Act entitled "An Act to regulate interstate transportation of black bass, and for other purposes," approved May 20, 1926

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Act entitled "An Act to regulate the interstate transportation of black bass, and for other purposes," approved May 20, 1926 (U. S. C., Sup. III, title 16, secs. 851–856), is amended to read as follows:

"That when used in this Act the word 'person' includes company, partnership, corporation, association, and common carrier.

"SEC. 2. It shall be unlawful for any person to deliver or knowingly receive for transportation, or knowingly to transport, by any means whatsoever, from any State, Territory, or the District of Columbia, to or through any other State, Territory, or the District of Columbia, or to or through any foreign country, any large-mouth black bass (Micropterus salmoides) or any small-mouth black bass (Micropterus dolomieu), if (1) such transportation is contrary to the law of the State, Territory, or the District of Columbia from which such black bass is or is to be transported, or (2) such black bass has been either caught, killed, taken, sold, purchased, possessed, or transported, at any time, contrary to the law of the State, Territory, or the District of Columbia in which it was caught, killed, taken, sold, purchased, or possessed, or from which it was transported; and no person shall knowingly purchase or receive any such black bass which has been transported in violation of the provisions of this Act; nor shall any person receiving any shipment of black bass transported in interstate commerce make any false record or render a false account of the contents of such shipment.

"SEC. 3. Any package or container containing such black bass transported or delivered for transportation in interstate commerce, except any shipment covered by section 9, shall be clearly and conspicuously marked on the outside thereof with the name 'Black Bass,' an accurate statement of the number of such fish contained therein, and the names and addresses of the shipper and consignee.

"SEC. 4. All such black bass transported into any State, Territory, or the District of Columbia for use, consumption, sale, or storage therein, shall upon arrival in such State, Territory, or the District of Columbia be subject to the operation and effect of the laws of such State, Territory, or the District of Columbia to the same extent and in the same manner as though such fish had been produced in such State, Territory, or the District of Columbia, and shall not be exempt therefrom by reason of being introduced therein in original packages or otherwise.

"SEC. 5. The Secretary of Commerce is authorized (1) to make such expenditures, including expenditures for personal services at the seat of government and elsewhere, and for cooperation with local, State, and Federal authorities, including the issuance of publications, and necessary investigations, as may be necessary to execute the functions imposed upon him by this Act and as may be provided for by Congress from time to time; and (2) to make such regulations as he deems necessary to carry out the purposes of this Act. Any person violating any such regulation shall be deemed guilty of a violation of this Act.

"SEC. 6. (a) Any employee of the Department of Commerce authorized by the Secretary of Commerce to enforce the provisions of this Act (1) shall have power, without warrant, to arrest any person committing in the presence of such employee a violation of this Act or any regulation made in pursuance of this Act, and to take such person immediately for examination or trial before an officer or court of competent jurisdiction; (2) shall have power to execute any warrant or other process issued by an officer or court of competent jurisdiction to enforce the provisions of this Act or regulations made in pursuance thereof; and (3) shall have authority, with a search warrant issued by an officer or court of competent jurisdiction, to make search in accordance with the terms of such warrant. Any judge of a court established under the laws of the United States or any United States commissioner may, within his respective jurisdiction, upon proper oath or affirmation showing probable cause, issue warrants in all such cases.

"(b) All fish delivered for transportation or which have been transported, purchased, received, or which are being transported, in violation of this Act or any regulations made pursuant thereto, shall, when found by such employee or by any marshal or deputy marshal, be summarily seized by him and placed in the custody of such persons as the Secretary of Commerce shall by regulations prescribe, and shall, as a part of the penalty and in addition to any fine or imprisonment imposed under section 7 of this Act, be forfeited by such court to the United States upon conviction of the offender under this Act, or upon judgment of the court that the same were transported, delivered, purchased, or received in violation of this Act or regulations made pursuant thereto.

"SEC. 7. In addition to any forfeiture herein provided, any person who shall violate any of the provisions of this Act shall, upon conviction thereof, be punished by a fine not exceeding $200, or imprisonment for a term of not more than three months, or by both such fine and imprisonment, in the discretion of the court.

"SEC. 8. Nothing in this Act shall be construed to prevent the several States and Territories from making or enforcing laws or regulations not inconsistent with the provisions of this Act, or from making or enforcing laws or regulations which shall give further protection to large-mouth and small-mouth black bass.

"SEC. 9. Nothing in this Act shall be construed to prevent the shipment in interstate commerce of live fish and eggs for breeding or stocking purposes."

Approved, July 2, 1930.

DEVELOPMENT OF FISH SCREENS AND FISHWAYS

Under the act of Congress approved May 1, 1928, the bureau was directed to determine the best means of preventing the destruction of fishes in irrigation ditches, canals, and other works. During the two years of investigation substantial progress has been made in the solution of the problem.

In the small to moderately large diversions, the most practical and economical type of mechanical fish screen consists essentially of a cylinder of heavy wire-mesh material placed in an appropriate supporting structure and made to revolve on a horizontal axis in the direction of the stream flow, the motive power being furnished by a paddle or bucket wheel placed in the ditch below the screen. In addition it is provided with the necessary by-pass channel for return of the fish to the main stream. The type found to be the most practical was that adopted by the Oregon Game Commission and the Washington Division of Fisheries.

As a result of continued experimentation, the electric fish screen for large diversions has been developed to a stage where it is successful in diverting upstream migrating fish from tailrace waters; it has been of value also for diverting downstream migrants from intakes, but further experiments are needed to increase its efficiency, simplify its design, and reduce its cost. Additional experiments should be made to determine the best type of current and the best voltage values to be specified for electric screens.

During 1928 practically all fish ladders in the States of Washington, Oregon, Idaho, and Montana were inspected and studied. Observations were made of the habits of migratory fish to discover the basic principles which should govern the design of fishways. In 1929, practical application of these principles was made in the construction of a new fish ladder at the Sunnyside Dam near Yakima, Wash., which revealed the efficiency of fish ladders of large pool design. In addition, the design of a new fish ladder for the Sprague River Dam near Chiloquin, Oreg., was begun, studies made of Canadian data on the subject, and several proposed power sites were inspected, including the study of models and designs of fish ladders for the purpose of determining more definitely the requirements at these projects. The examination of proposed power projects and the prompt giving of the specifications necessary for fish-protective structures are of vital importance. The bureau has received very helpful cooperation from Federal and State authorities, power interests, and other agencies.

UPPER MISSISSIPPI RIVER SITUATION

The upper Mississippi River situation with respect to mussels, fin fisheries, pollution, the possible effects of flood control and improvements to navigation, and the importance of properly developing the aquatic resources of the Upper Mississippi Wild Life and Fish Refuge presents a very serious and complex problem.

Only a few areas from Lake Pepin, Minn., to Quincy, Ill., are still productive of mussels in a commercial way. The evidence indicates that conditions in the Mississippi River within this area are no longer suitable for the development of the glochidia, and the mussel fishery of this region appears to be doomed to economic exhaustion. From Minneapolis to the lower end of Lake Pepin the fisheries situation is bad, the catch of fish in the lake declining from 3,572,000 pounds in 1922 to 386,000 pounds in 1929. On February 4, 1930, the metropolitan drainage commission of St. Paul and Minneapolis reported the oxygen content of the lake water as two and two-tenths parts per million at Frontenac, Minn., near the upper end of the lake, and two and seven-tenths parts per million at Lake City in the lower section. Thus in the upper end of the lake, at least, the oxygen content dropped below the safety point for the maintenance of fish life. Observations on a number of sloughs along the upper Mississippi River in Minnesota and Wisconsin show a reduction of oxygen content below the safety point. The conditions of the river cited above appear to be due largely to the joint action of pollution and erosion silt.

Conservationists have stressed the possible dangers to aquatic life which may occur through changed conditions resulting from the construction of dams and the dredging of deeper navigation channels in this area, and have urged that arrangements be made so that biologists of the Bureaus of Fisheries and Biological Survey will be afforded cooperative arrangements for the purpose of calling attention to these potential dangers and suggesting the need for remedial changes. For example, sudden changes in water level may prove very destructive to fish life and detrimental to the birds and mammals of the region. This may impair the value of the Mississippi Wild Life and Fish Refuge, as well as nullify the compacts entered into with the Legislatures of Minnesota, Iowa, Wisconsin, and Illinois and ratified by Congress.

The bureau has reorganized its staff of biologists and rearranged its program of investigations in this upper Mississippi River area to reveal with greater definiteness the conditions which obtain and the steps necessary to restore the productivity in mussels and fish. It has cooperated also with the Engineer Corps of the Army in considering plans of improvement of navigation to provide more stable conditions and, if possible, to improve the situation with respect to wild life and fish.

SPECIAL SENATE COMMITTEE ON WILD LIFE RESOURCES

On April 17, 1930, there was appointed (under S. Res. 246) a special committee of five Senators to investigate all matters pertaining to the replacement and conservation of wild life with instructions to report its findings to the Senate as soon as possible. The studies have to deal with a vast range of subjects, including the fishes of the Atlantic, Pacific, Gulf, and inland waters, and the fur-seal and fishery industries. At the conclusion of its exhaustive studies, which will extend over a period of more than a year, the committee plans to recommend to the United States Senate any changes or additions that they consider necessary in or to existing laws pertaining to conservation.

ALASKA FISHERIES SERVICE

ADMINISTRATION OF FISHERY LAWS AND REGULATIONS

Under the White fisheries law of June 6, 1924, which virtually gives the Secretary of Commerce authority to prescribe when, where, and how commercial fishing may be conducted in the waters of Alaska, steady progress has been made toward stabilizing the fisheries industry—the most important economic resource of the Territory. While regulations will not prevent fluctuations resulting from conditions that can neither be foreseen nor controlled, the results achieved in the six years since the passage of this act leave no room for doubt as to the value of the conservation measures that have been in effect during that time.

Of primary importance in preventing depletion of the fisheries is the securing of an escapement sufficient for the adequate seeding of the spawning beds. This is brought about by means of weekly closed periods and closed seasons during which all commercial fishing ceases, by limitation on the quantity and kind of gear that may be used, and by the establishment of closed areas wherein commercial fishing is prohibited. Such control necessitates constant observation of conditions in all districts throughout the fishing season so that prompt modifications may be made in existing regulations to meet unforeseen developments with respect to the volume of the runs.

Coincident with the enforcement of regulations to assure the escapement of at least 50 per cent of the salmon runs is the work of removing log jams and other barriers that prevent the fish from ascending the streams. Predatory enemies of the salmon are destroyed where it appears that their depredations are taking an undue toll of the young fish. Material assistance was given by the Territorial legislature in 1929 through the appropriation of $40,000 for these purposes.

In 1929, 12 statutory and 216 temporary employees were engaged in the patrol of the fishing grounds in addition to the crews of 14 vessels belonging to the bureau and 10 chartered vessels. Many of the temporary employees provided their own launches. An airplane was used experimentally for the first time in connection with the fisheries patrol in southeastern Alaska, and the advantages of aircraft as an auxiliary patrol were demonstrated.

During the active salmon-fishing season the Commissioner of Fisheries spent several weeks in Alaska, including a visit to the Pribilof Islands, keeping in close touch with all important matters pertaining to the fisheries industry. Modifications of existing regulations were made on his recommendation from time to time as the season advanced. On December 19, 1929, revised regulations to be effective in the following calendar year were issued.

ALASKA SALMON HATCHERIES

At the Government hatcheries at Afognak and on McDonald Lake 38,095,120 red-salmon eggs, 2,650,000 pink-salmon eggs, and 150,000 steelhead-trout eggs were collected in 1929. From these collections, shipments of 4,553,200 red-salmon eggs and 1,021,000 pink-salmon eggs in the eyed stage were forwarded to Seattle in October. At the privately owned hatchery operated under the provisions of the Alaska fisheries act of June 26, 1906, 11,760,000 red-salmon eggs were collected.

SPECIAL STUDIES AND INVESTIGATIONS

An important factor in the conservation of the fisheries is the securing of scientific knowledge of the life history and habits of the various species. This work was continued in Alaska during 1929. A detailed discussion of the various activities will be given later in this report.

Weirs for counting the numbers of salmon ascending to the spawning grounds were maintained in 20 typical salmon streams, of which 6 were in southeast, 12 in central, and 2 in western Alaska. Through the operation of such weirs the ratio of escape to catch is established and valuable information is acquired as to the probable return from a known escapement. Observations of the condition of the spawning grounds were made in all districts.

PRODUCTS OF THE FISHERIES

In 1929 salmon products, which comprise upward of 80 per cent in value of the Alaska fishery products, amounted to 272,244,435 pounds valued at $42,524,845. This is somewhat less than the output for the preceding year when 308,691,203 pounds of salmon products valued at $47,487,763 were prepared; but it compares favorably with the average of approximately 265,570,000 pounds, valued at $39,312,586, for the 5-year period from 1924 to 1928, inclusive. About 95 per cent of the salmon products in 1929 consisted of canned salmon, the pack amounting to 5,370,159 cases valued at $40,469,385.

The quantity of herring products exceeded that of any preceding year except 1925, but a large percentage consisted of meal and oil because of the unusually small size of the fish taken. The value of the herring products was the lowest since 1924. There was a considerable increase over the previous year in the amount and value of the halibut

taken by the Alaskan fleet. Whaling was conducted on about the same scale as in recent years. Of the several minor fisheries, the output of clams showed the greatest increase.

The total value of all fishery products of Alaska in 1929 was $50,795,819, as compared with $54,545,588 in the preceding year and an average of $45,941,358 for the 5-year period from 1924 to 1928, inclusive. Of this total, $42,524,845 represented the value of the salmon output; $4,422,605, halibut; $2,794,084, herring; $502,081, whale products; $203,656, clams; $200,312, shrimps; and $148,236, miscellaneous fishery products. The value of the catch to the fishermen was approximately $16,582,000, or about $761,000 less than in the preceding year. There were 29,283 persons employed in the various branches of the industry, as compared with 31,086 in 1928.

The extent and condition of the Alaska fisheries in 1929 and of the activities of the bureau under the laws and regulations for the protection of the fisheries are covered in detail in the annual report of the Alaska service for that year.

ALASKA FUR-SEAL SERVICE

GENERAL ACTIVITIES

The Government management of the Pribilof Islands fur-seal herd, under conditions brought about by the North Pacific Sealing Convention of 1911, has resulted in a gradual and steady increase in the number of animals, making it possible to secure more pelts of surplus males in successive seasons without detriment to the growth of the herd. The increase in the annual killings has given rise to the question of more profitable disposition of the seal carcasses—the main utilization of which heretofore has been as food for the fox herds on the islands, although some reduction of meal and oil has been accomplished at various times. Accordingly, the erection of a modern by-products plant was begun in the early summer of 1930.

Under the direction of the bureau's staff of employees, sealing operations on the Pribilof Islands are performed by the natives. The upkeep and replacement of buildings and the extension of improved roads are given due attention each year, the work being carried on chiefly when sealing activities are not pressing. The care and feeding of the blue-fox herds on St. Paul and St. George Islands provide additional occupation during the winter. In return for their services the native population, consisting of 368 persons, are furnished food, clothing, and shelter, as well as schools and medical aid. Further compensation is made in cash at the rate of 75 cents for each sealskin and $5 for each fox skin taken, with some additional payments for special services.

The need of a new vessel to serve as tender for the Pribilof Islands had been felt for some time, the *Eider* having become inadequate both by reason of its limited capacity and because of its long service in the exposed waters of Bering Sea. A new power vessel, *Penguin*, designed especially for such service, was built in the fiscal year 1930 and is proving to be well adapted for the duties required. The *Penguin* sailed from Seattle on May 5 on its maiden voyage to the islands, carrying seasonal employees of the bureau and about 185 tons of supplies.

Through the cooperation of the Navy Department the annual supplies for the Pribilof Islands were transported from Seattle, Wash., on the U. S. S. *Sirius*, and the sealskins and fox skins then ready for shipment were brought back on the return voyage.

SEAL HERD

The computed number of animals in the Pribilof Islands fur-seal herd on August 10, 1929, was 971,527—an increase of 100,014, or 11.48 per cent, over the corresponding figure for 1928.

TAKE OF SEALSKINS

In the calendar year 1929 there were taken on the Pribilof Islands 40,068 fur-sealskins, of which 33,216 were from St. Paul Island, and 6,852 from St. George Island. This was an increase of 8,969 over the number taken in 1928 and is the largest take of any year since 1889.

MARKING RESERVED SEALS

In 1929 the number of 3-year-old male seals marked for the breeding reserve was 8,085, of which 6,430 were on St. Paul Island, and 1,655 on St. George Island. The marking was done by shearing a patch of fur, and on St. Paul Island 200 of the animals so marked were also branded with a hot iron.

SALE OF SEALSKINS

Two public auction sales of fur-seal skins taken on the Pribilof Islands were held at St. Louis, Mo., in the fiscal year 1930. The first was on September 30, 1929, when 5,022 black-dyed and 9,000 logwood brown-dyed skins were sold for a gross price of $349,648. At the same time 142 logwood brown-dyed and 10 raw-salted Japanese fur-seal skins brought $3,486.50. These 152 skins were the United States Government's share of sealskins taken by the Japanese Government in 1928. In addition, 2 confiscated fur-seal skins, dyed logwood brown, were sold for $33, and 5 confiscated sea-otter skins were sold for $963.

At the second sale, held on April 7, 1930, 8,011 black-dyed and 6,035 logwood brown-dyed skins were sold for $319,290, and 4 confiscated skins (2 dyed logwood brown, 1 dressed in hair, and 1 raw salted) brought $16.50.

Special sales of sealskins, authorized by the Secretary of Commerce, in the fiscal year 1930 consisted of 125 black-dyed and 75 logwood brown-dyed skins at a gross price of $8,807.86. All were taken at the Pribilof Islands.

FOXES

The care of foxes on the Pribilof Islands is incidental to sealing operations, requiring attention only during the winter months.

Five hundred and forty-four blue and nine white fox skins taken in the season of 1928–29 were sold at public auction on September 30, 1929. The blue pelts brought $35,865 and the whites $556, a total of $36,421.

In the season of 1929–30, 193 blue and 31 white fox skins were taken on St. Paul Island and 552 blues and 1 white on St. George Island, a total of 777 skins. Seventy-two foxes on St. Paul Island and 546 on St. George Island were trapped, marked, and released for breeding purposes. Additional foxes, not caught in the traps, were also included in the breeding reserve.

FUR-SEAL SKINS TAKEN BY NATIVES

The privilege of taking fur seals at sea under specified limitations is granted to natives of the Pacific coast by the provisions of the North Pacific Sealing Convention of July 7, 1911. Before the sealskins can enter into commerce they must be authenticated as having been lawfully taken. One thousand five hundred and eighty-six fur-seal skins taken in 1929 have been authenticated by the Government, 995 of which were taken in the offshore waters of southeastern Alaska and 591 in waters off the coast of Washington. Through the courtesy of the Department of the Interior, the latter skins were authenticated by the superintendent of the Neah Bay Indian Agency. An official report stated that 3,383 fur-seal skins were taken by natives of British Columbia in 1929.

FUR-SEAL PATROL

As in previous years, a patrol for the protection of the fur seals and sea otters in the waters of the North Pacific Ocean and Bering Sea was maintained by vessels of the United States Coast Guard. Two of the bureau's vessels were likewise engaged in the fur-seal patrol during the spring migration of the herd.

Under date of September 24, 1929, there was issued a revised (second) edition of the circular containing the laws and regulations for the protection of fur seals and sea otters, which embodied the Executive order of January 14, 1929, naming each of the bureau's vessels in the Alaska service as authorized to take part in the fur-seal patrol.

PROTECTION OF SEA OTTERS, WALRUSES, AND SEA LIONS

Revised regulations for the protection of walruses and sea lions were issued as of May 1, 1930, extending the closed season on these animals for another 2-year period. Permission to kill the animals under certain restricted conditions previously set forth was continued. The killing of sea otters is prohibited at all times.

BIOLOGICAL FISHERY INVESTIGATIONS

The division of scientific inquiry during the fiscal year 1930 continued biological investigations of the fisheries intended to promote the conservation activities of the various States, to foster and encourage aquiculture, and to aid industry in the proper utilization of aquatic food resources. The division's most important function is the acquiring of fundamental knowledge of the fisheries—marine, commercial, fresh-water, or sports—to serve as the basis for so regulating the take that an adequate breeding stock will be maintained, assuring continued productivity of the supply. In addition to prohibitory or

regulatory recommendations, investigations are conducted as a means of increasing the output of the hatcheries and of more wisely directing the planting and stocking system. Studies have also been conducted on the problem of increasing the productivity of natural water areas and on fish farming in small lakes and ponds.

Major projects of research are conducted in each of the geographical sections and coasts of the United States and the more important interior waters, covering some 28 important commercial and game fishes, as well as studies of organisms related to these species either as food or as enemies.

Outstanding progress has been made in the aquicultural investigations that are concerned primarily with increasing the output of hatcheries and the stocking of interior waters with food and game fishes. Of more direct benefit to the commercial fisheries are the investigations on shellfish culture, particularly in the farming of oyster bottoms and in the investigation of the commercial fisheries of the North Atlantic. A most direct method of conservation of the salmon of the Pacific Coast States is preventing the destruction of millions of young salmon entering irrigating canals while migrating to the sea from the spawning places in the headwaters of the rivers. The bureau's installations of experimental screens at the mouths of irrigating ditches are proving particularly effective.

AQUICULTURAL INVESTIGATIONS

The division's fresh-water investigations in aquiculture are included under four headings: Experimental trout culture, experimental bass culture in ponds, experimental fish culture in the Upper Mississippi River Wild Life and Fish Refuge, and studies on the pathology of hatchery fish. Several years' experiments in the use of various substitutes for fresh meat in the diet of brook trout have culminated in the adoption of an ideal ration that includes dry meals with the regulation beef liver and beef heart diet in sufficient quantities to reduce the total cost of feeding by about 50 per cent. These perfected rations not only produce excellent growth in the fry and fingerlings but reduce mortality to a minimum and permit the holding of trout at hatcheries until greater size is reached before planting. Experiments on selective breeding are also under way that give promise of producing a superior strain of brood stock that is rapid growing, disease resisting, and above the average in egg production.

At the bureau's pond-culture station, experiments on the rearing of black bass have been equally successful. Better and more efficient methods have been devised for propagating and rearing the warm-water game fishes, such as the large and smallmouth black bass, the white and black crappie, and the bluegill sunfish. By the proper use of minnows as forage fish and by the fertilizing of ponds with commercial and chemical fertilizers, the bureau has produced as high as 11,500 fingerling bass per acre, and one of its ponds has averaged 8,500 per acre for three years.

In the Upper Mississippi Wild Life and Fish Refuge a number of sloughs and ponds in the overflowed lowlands of the river valley have been prepared for intensive fish production, and detailed limnological observations on the abundance of fish and the character of fish food available in the area have been made. One of the most

serious difficulties in fish culture of the region is due to the rank growth of aquatic vegetation. Chemical treatments have been devised which will destroy the coarser plants without injury to the fish or interference with the food supply. Such treatments are being applied to the ponds in the refuge and will have practical application to pondfish culture throughout the country.

The bureau's pathologist has continued his studies on the diseases of trout and has rendered invaluable service not only to the bureau's hatchery superintendents through the diagnosis and treatment of disease in hatcheries, but to many State and private fish-culturists. This line of work is so productive that plans are laid for its expansion as rapidly as funds will permit.

FISHERIES OF THE ATLANTIC AND GULF COASTS

Fundamental studies on the factors that affect the abundance of fish in the great commercial fisheries of the Atlantic seaboard have been undertaken during the past two years with the aid of the fisheries steamer *Albatross II* and a staff of shore observers. Studies of the chemical and physical condition of the water and its contained floating life have been made at various seasons of the past year in order to judge the success of spawning of various important species and the influences that control their migrations. A comprehensive report on the migrations and biology of the cod of southern New England is now in press, and rapid progress has been made on studies of the stock of mackerel. The erratic appearance and disappearance of huge stocks of mackerel in Atlantic waters is now known to be due to variations in actual abundance resulting from the occurrence of successful spawning at fairly infrequent intervals, and it has been possible to predict with increasing accuracy the commercial runs of the following season.

Investigations of the shore fisheries of southern New England and the Middle Atlantic States, begun two years ago, indicate that similar causes control the abundance of other important species and that the decline in productivity of the squeteague, or weakfish, in recent years is the result of natural rather than artificial causes.

Much of the understanding of the biology of these food fishes depends upon a knowledge of their early life history. A deliberate attack upon this problem has been made in connection with the oceanography of the North Atlantic region by extensive collection and study of the eggs and larvæ obtained in the surface waters and in a program of collections in the South Atlantic region at the Beaufort biological station.

On the Gulf coast, studies of the fauna have been continued with the aim of eventually producing a manual of the marine fishes that will give descriptions of the species and the pertinent facts in their life history, habits, and economics.

FISHERIES OF THE PACIFIC COAST AND ALASKA

Investigation of the commercial fisheries of the Pacific coast and Alaska have been restricted to the salmon runs of Alaska, to the completion of salmon-tagging experiments on the Columbia River, and continuation of the Alaska herring studies. New investigations

during the year included a study of the homing instinct of pink salmon in Alaska, an investigation of the red salmon of the Copper River, and a study of the red-salmon runs of the Bristol Bay district. The compilation and analysis of the statistics of the salmon fisheries of central Alaska were completed during the year. Intensive investigations of the red-salmon run of the Karluk River were continued as a part of the general program of determining the normal return from known escapements of spawning fish.

In the Chignik River, the Copper River, and in certain sections of Bristol Bay similar investigations are under way. In undertaking an investigation of the pink salmon in southeastern Alaska, the most pressing problem was the early settlement of the question of the relative strength of the homing instinct in this species. Forty-six salmon streams were visited and data collected.

Field work on the Columbia River was restricted to the recovery of mature fish that had been marked years before as fingerlings to determine how long the fingerlings should be held at hatcheries before planting. The experiment further substantiated the parent stream theory, but failed to indicate any advantage of one age of liberation over another.

The bureau has published a very complete report on the herring fishery of Alaska, in which the occurrence of distinct racial units in the stock is demonstrated and the relation of catch composition to fluctuations in abundance with a summary of the evidence of depletion is presented.

FISHERIES OF THE GREAT LAKES

Investigations of commercial fisheries of Lake Erie and Lake Huron were continued. The study of the relative destructiveness of gill nets and trap nets of various sized meshes was completed and served as a basis for the new regulations passed in Ohio. They also served as a basis for the revision of the commercial fisheries laws in Michigan and Indiana, and for recommendations offered to Wisconsin, Minnesota, and New York. As a result of the bureau's continued effort, all the States bordering the Great Lakes except Minnesota have now introduced the recommended method of collecting fishery statistics showing the daily catch together with the amount of gear employed.

Cooperative investigation of the limnology of Lake Erie to discover normal conditions favoring fish growth as well as possible effects of pollution or other factors limiting fish production, undertaken jointly by the bureau and the States of Ohio and New York and private institutions, was completed during the year, and data are being compiled and analyzed. In addition, the bureau cooperated directly with the Ohio division of fish and game in conducting an intensive limnological investigation of the western end of Lake Erie in connection with the studies on the distribution of larval and postlarval fish and the possible effects of pollution.

INTERNATIONAL INVESTIGATION OF THE LAKE CHAMPLAIN FISHERY DISPUTE

Personnel of the Bureau of Fisheries cooperated with Canadian investigators in an investigation of the fisheries of Lake Champlain to settle the dispute between the sportsmen of the United States and

the commercial fishermen of Canada, all of whom exploit the pike perches as sports fishes in the United States waters and as a commercial fishery in the Missisquoi Bay region of Quebec. The chief features of the biology of these species will be determined in order to judge the interdependence of the waters on both sides of the international boundary in the hope of reaching an amicable settlement of this old controversy.

SHELLFISH INVESTIGATIONS

Oysters.—Oyster investigations during the past year consisted in the experimental study of oyster culture in New England, Georgia, Texas, and Washington, in a study of the physiology of adult and larval oysters, in a study of the effect of pulp-mill waste on oysters of the Puget Sound, and in an investigation of the biology of the natural enemies of the oyster such as the oyster drill and starfish. Several years' investigations of the oyster fishery resulted in a number of publications recently issued. Much interest has been aroused in the oyster industry by the development of a new and more efficient type of oyster spat collector, consisting of a cement-coated paper crate resembling egg crate partitions, with the result that this method of increasing seed oyster production is being generally adopted by the industry.

Studies of oyster culture in lower Puget Sound, begun last year, indicated that the beds in Oakland Bay were being destroyed. A hydrobiological and a physiological investigation was undertaken to determine the cause of this failure. Laboratory tests showed that waste sulphite liquor from a pulp mill in the vicinity would kill oysters or interfere with their feeding activities. On the basis of calculations of the amount of liquor dumped into the bay during the past two years and from tidal studies it is estimated that the bay contained sulphite liquor in sufficient concentration to produce such toxic effects. A preliminary report was prepared in which it was recommended that sulphite liquor be excluded from waters in which oysters are produced.

Studies on the control of starfish pests on the oyster beds of Long Island Sound give promise of developing an efficient treatment for killing the starfish soon after the spawning of these animals in the spring by means of copper sulphate. Because of the practical importance of this work the investigation will be continued.

Fresh-water mussels.—Investigations of improved methods of mussel culture were continued during the early part of the fiscal year. A thoroughly successful laboratory method for artificial propagation of the valuable fresh-water mussels has been hindered in large-scale production by the extensive pollution of the upper Mississippi River system. An extensive survey of the waters of Arkansas, Louisiana, Texas, and northern Mexico, as well as tributaries of the Mississippi farther north, was undertaken to discover areas suitable for the extension of mussel culture, and a systematic effort was made in the spring of 1930 to secure a breeding stock free from the effects of pollution and suitable for obtaining spawn for incubation.

The scientific staff engaged on these problems has been reorganized, field headquarters have been established at the University of Missouri, Columbia, Mo., and experiments have been undertaken to test the suitability for artificial culture of mussels from widely spread localities.

A study of the effects of pollution upon the fresh-water mussel and a survey of the streams in the Middle West yield information of direct value in stocking these waters with food and game fishes, and it is intended to expand activities in this direction as rapidly as funds will permit.

STATISTICAL SURVEYS

The statistical work of the division of fishery industries included the collection and dissemination of biological and trade-fishery statistics. Further progress was made toward the collection of annual statistics of the entire country by greater cooperation with State fishery agencies and by the use of automobiles by agents. As a result, catch statistics for 1928 were obtained for the fisheries of the New England, South Atlantic, Gulf, Pacific Coast, and Great Lakes States.

MANUFACTURED PRODUCTS

Canned products.—During 1929, 497 establishments were engaged in the canning of fishery products in the United States and Alaska. The total production amounted to 689,446,781 pounds net weight, valued at $101,065,055. This is an increase of 5 per cent in value compared with the respective value of the production in 1928. Salmon canned on the Pacific coast, mainly in Alaska, accounted for 6,990,682 standard cases (335,552,736 pounds), valued at $56,085,697. This is 55 per cent of the total value of all products canned in 1929. Sardines with a production of 5,857,016 standard cases (234,543,345 pounds), valued at $18,894,943, accounted for 19 per cent of the total value. Sardines were canned in California, Maine, and Massachusetts. Tuna and tunalike fishes with a production of 1,504,306 standard cases (36,103,344 pounds), valued at $9,873,453, accounted for 10 per cent of the value. Tuna and tunalike fishes were canned only in California. The remainder of the production consisted principally of shrimp, oysters, clam products, and mackerel.

By-products.—During 1929 by-products of the fisheries worth $23,767,656 were manufactured. The most important were 15,353,057 gallons of marine-animal oils, with a value of $6,801,619; 142,681 tons of marine-animal meals and scrap with a value of $6,801,362; fresh-water mussel shell products, such as buttons and novelties, valued at $6,144,515; and 334,766 tons of oyster-shell products, such as lime and crushed shell for poultry, valued at $2,524,499. The remainder, valued at $1,495,661, consisted of such commodities as herring skins and scales, shark skins and fins, fish flour, agar agar, glue, and various miscellaneous products.

FROZEN FISH

In 1929 there were 122 plants in the United States and Alaska freezing fishery products and 168 cold-storage warehouses which stored frozen-fishery products. The quantity of fish frozen amounted to 121,542,589 pounds, with an estimated value in the cold-storage warehouses of $15,000,000. The average monthly holdings amounted to 55,900,000 pounds in 1929, or 17 per cent over the 5-year average of monthly holdings. The freezing plants are capable of packing about 3,617,000 pounds of frozen fish per working day, and the cold-storage warehouses are capable of holding a maximum of 209,660,000 pounds of fishery products at one time.

PACKAGED FRESH, FROZEN, AND SMOKED FISH

Packaged fresh, frozen, and smoked fish were produced in 112 plants (27 more than in 1928) operated in 12 States. The output amounted to 84,396,505 pounds, valued at $14,812,987, which represents an increase of 29 per cent in amount and 51 per cent in value when compared with the trade in 1928. It is estimated that 212,000,000 pounds of whole round fish were utilized.

FOREIGN FISHERY TRADE

The value of the United States foreign trade in fishery products during 1929 amounted to $90,395,769, of which $66,565,599 represents the value of imports for consumption and $23,830,170 the value of exports. Compared with the previous year, this is an increase of 13 per cent in total trade, in the value of the imports, and in the value of the exports, respectively.

NEW ENGLAND STATES

In 1929 the fisheries of Maine, New Hampshire, Massachusetts, Connecticut, and Rhode Island employed 16,659 fishermen, or 11 per cent more than in 1924. The catch amounted to 603,598,050 pounds, valued at $25,619,904. This is an increase of 48 per cent in the catch and 36 per cent in value of the catch as compared with the quantity and its value in 1924.

Vessel fisheries.—In 1929 landings of fish by American vessels at Boston and Gloucester, Mass., and Portland, Me., amounted to 327,096,327 pounds as landed, valued at $13,051,704, and were larger than the amount and value of the landings for any one year for which there are records. Of this amount, 187,203,733 pounds were haddock.

Mackerel fishery.—The mackerel fishery showed a sharp recovery from the decline in 1926 to 1928. The total catch amounted to over 46,000,000 pounds and was 49 per cent greater than the previous year. The gain was due to the appearance of a new year class, which furnished nearly 21,000,000 pounds of small mackerel.

Packaged-fish trade.—Packaged-fish trade in New England, centering at Boston and Gloucester, Mass., and Groton, Conn., expanded during 1929, and the increased production over 1928 was about 50 per cent.

Canned sardines.—The sardine canners in Maine and Massachusetts packed 2,025,801 standard cases, valued at $6,897,946 during 1929. Production was about the same as in 1928, but the value was considerably less.

MIDDLE ATLANTIC STATES

According to the latest general canvass of the fisheries of these States (New York, New Jersey, Pennsylvania, and Delaware) made for 1926, the situation can not be considered as giving reasons for optimism as the production of many of the staple fish showed heavy declines as compared with 1921. Landings of fish at New York City and Groton, Conn., amounted to 75,325,000 pounds in 1929. This is somewhat more than in 1928. The production of menhaden in 1929 was somewhat under that for 1928.

Shad fishery.—On the Hudson River the shad fishery was carried on by 241 fishermen and yielded 56,480 shad which weighed 196,745 pounds, valued at $30,683 to the fishermen. This represents a decline of 29 per cent both in number and value as compared with the production in 1928.

CHESAPEAKE BAY STATES

The Virginia menhaden industry recovered somewhat from the poor year of 1928, and produced a larger quantity of scrap and meal, but the value barely exceeded that for 1928. There was a smaller oil production selling at a lower price in 1929 than in 1928, with the net result that the total value of the menhaden industry in Virginia in 1929, in spite of increased production, was about the same as in 1928. This situation reveals the need for improved methods in the manufacture of menhaden meal and oil with a view toward the production of a higher quality product.

Conditions in the oyster industry were little changed, although distribution has not yet kept pace in some parts of the country. The crab industry had one of its best years in 1929, according to the reports of persons in the trade. The production of packaged fish in 1929 about equaled that for 1928.

Shad fishery.—In 1929 shad and alewife fisheries of the Potomac River were prosecuted by 773 fishermen. It yielded 317,253 fish that weighed 1,052,284 pounds, valued at $141,589 to the fishermen. Compared with the yield for 1928 this is a decrease of 56 per cent in number, 49 per cent in weight, and 34 per cent in value.

SOUTH ATLANTIC STATES

In 1928 the fisheries of North Carolina, South Carolina, Georgia, and the east coast of Florida employed 11,882 fishermen, or 3 per cent more than in 1927. The catch amounted to 258,440,435 pounds, valued at $6,027,154, which is a decrease of 1 per cent in catch and an increase of 6 per cent in value when compared with 1927.

The production of canned shrimp in 1929 was somewhat higher than in 1928. The menhaden industry, which is rapidly becoming a factor in the fisheries of these States, showed a considerably increased production in 1929 over that in 1928.

GULF STATES

According to available records for 1928, the fisheries of Alabama, Mississippi, Louisiana, Texas, and the west coast of Florida have been exceeded only in 1927, from which year they decreased 2 per cent in amount and 1 per cent in value. They employed 16,356 fishermen, or 8 per cent more than in 1927. The catch amounted to 191,007,176 pounds, valued at $9,866,263. The production of canned shrimp in 1929 was about the same as in the previous year, while the production of canned oysters was considerably in excess of the pack in 1928.

Florida sponge fishery.—In 1929 the quantity of sponges sold on the exchange at Tarpon Springs, Fla., amounted to 378,514 pounds, valued at $706,645. This is a decrease of 8 per cent in quantity and 3 per cent in value compared with the transactions in 1928.

PACIFIC COAST STATES

In 1928 the fisheries of Washington, Oregon, and California produced 693,484,447 pounds of products, valued at $20,512,772. Compared with 1927 this is a gain of 6 per cent in the quantity of the catch and a decrease of 8 per cent in its value. In making the catch 19,733 fishermen were employed, which is 4 per cent less than the number employed in 1927.

In 1929, a good year, the pack of salmon was 92 per cent greater than the previous year, the larger pack of humpback or pink salmon in Puget Sound constituting most of the increase. Compared with 1927, the previous "good" year, there was an increase of 8 per cent in the pack.

The pack of sardines in California was the largest on record, both in quantity and value, and amounted to 3,831,215 standard cases valued at $11,996,997, which is an increase of 38 per cent in quantity and 24 per cent in value, compared with 1928. The production of canned tuna in 1929 was the largest on record and amounted to 1,504,306 standard cases valued, at $9,873,453. This is an increase of 24 per cent in quantity and 18 per cent in value over the pack of the previous year.

The mackerel canning industry in California continued to expand in 1929, the production amounting to 592,451 standard cases, valued at $2,428,058. This is an increase of 52 per cent in quantity and 50 per cent in value when compared with the pack during 1928.

Halibut fishery.—In 1929 the total weight of the catch of halibut as landed by United States and Canadian vessels amounted to 55,490,000 pounds, valued at $6,698,000. This is about the same as the amount of the catch in 1928, but a little more than for the years 1925 to 1927. Of the total landings 84 per cent were taken by United States craft and 16 per cent by Canadian craft.

LAKE STATES

In 1928 the lake fisheries (Lakes Ontario, Erie, Huron, Michigan, Superior, and Namakan, Lake of the Woods, and Rainy Lake) of the United States and Canada produced 92,913,909 pounds of fish. Of the total, the United States accounted for 63,368,467 pounds, valued at $5,960,784. This is the smallest catch on record and the decrease can not be attributed to a decline in the catch of any one species, for practically all show a decline compared with their respective catches for 1927. The catch of ciscoes revealed the most serious decline; that in the United States in 1928 barely exceeding 600,000 pounds compared with a catch of about 35,000,000 pounds in 1918. A decrease occurred in the catch of every lake except Ontario. The Canadian catch amounted to 29,545,442 pounds, which is slightly less than the catch in 1927. The declining yields in the lake fisheries should prove an incentive to the various State authorities and the fishermen to promulgate wise conservation measures for preventing further decline in this important resource.

MISSISSIPPI RIVER AND TRIBUTARIES

The yield of fresh-water mussel shells in 1929, used in the manufacture of pearl buttons and novelties, amounted to 54,352,000 pounds valued at $1,324,919. This is a decrease of 6 per cent in

quantity and an increase of 4 per cent in value compared with the production and its value in 1922. The pearl-button industry, centering in Iowa, manufactured pearl buttons and various novelties from fresh-water mussel shells, to a value of $6,144,515 in 1929. The fisheries of Lakes Pepin and Keokuk show decreased yield in 1929 compared with that in 1928.

TECHNOLOGICAL INVESTIGATIONS

The division's technologists have been conducting research mainly on problems relating to the manufacture of fish meal and oil, the feeding value of marine products, the handling and transportation of fresh and frozen fish, and the preservation of nets.

NET PRESERVATION

In the study of trap-net preservation, selected new treatments have been tested on trap-net and gill-net threads in many fishing waters throughout the country. As a result certain essential principles of preservation applicable to all localities have been established. Technical development of gill-net preservatives has followed scientific study. Several fishermen have used gill nets treated with brown or green colored preservatives with results comparable to the fishing power of white nets.

BY-PRODUCTS

Menhaden.—The bureau's technical study of the menhaden industry included the determination and evaluation of the losses of material encountered in the reduction process and studies of methods applicable to the present process whereby such losses could be reduced. The various recovery methods studied indicate that either all or a considerable portion of press-liquor losses may be recovered at a profit. The same is true of the oil now lost. Studies on methods of drying press cake show that present dryer losses may be reduced over one-half by drying in a high-capacity steam dryer, and the resultant dried material is of better quality and has a greater nutritional value. Studies also indicate that a considerable reduction in the cost of raw material would result from proper storage conditions aboard vessel.

Reduction of waste from nonoily fish.—Studies on the reduction of this type of material show that it may be reduced in one operation with some success if dried under reduced pressure. Most desirable results were obtained by reducing the size of the initial charge and having scraping blades on the agitator come in direct contact with the dryer walls.

Waste fish and sharks.—Studies on the utilization of waste fish and sharks in amounts too small to warrant investment in mechanical reduction equipment, show that such material may be reduced from the raw state by acidulation and solar drying. By this simple procedure, many fishermen without any considerable effort or expense can realize a profit from material that is now little more than a nuisance.

NUTRITIVE VALUE OF FISHERY PRODUCTS

Research in the nutritive value of fishery products has consisted of the following: (1) A joint study by this bureau and the Bureau of Chemistry and Soils of the Department of Agriculture of the vitamin

potency of fish oils involving results of considerable interest to both the agricultural and fishery industries recently completed; (2) completion of a series of experiments at Johns Hopkins University involving the study of fish meals of different varieties and methods of manufacture on a comparative basis and as sources of animal protein; (3) practical feeding tests in which various kinds of fish meals and shellfish meals are being fed in the rations of dairy cows; (4) continuance of cooperation with the Bureau of Chemistry and Soils in the study of vitamins in oysters and in fish meals; and (5) cooperative practical feeding tests conducted by various Federal and State agricultural experiment stations in which the feeding value of marine products is being studied.

IMPROVED HANDLING OF FRESH AND FROZEN FISH

Several methods are being tried for the prevention of "rust" on frozen fish in cold storage. Preliminary work seems to indicate that some of these may prove satisfactory.

Methods for the prevention of losses incurred in weight and food and mineral values of fish packed in contact with crushed ice are being studied.

The bureau's agent in Boston has suggested the use of a platform for unloading the vessels at the fish pier to eliminate forking and excessive labor; the use of an improved filleting table in the packing houses; insulation of the holds of vessels; and improved methods for preserving cod livers aboard vessel.

OYSTER MARKET SURVEY

During 1929 the bureau conducted a survey of the wholesale and retail marketing of oysters. This was made in cooperation with the Oyster Growers and Dealers Association of America (Inc.) and certain State officials.

In this survey 1,393 housewives and 127 dealers were visited in 14 cities in 13 States in the section of the country east of the Rocky Mountains. Of the consumers interviewed it was found that 86.8 per cent use oysters from 1 to 122 times per year. The average per capita consumption in all the cities surveyed was found to be 4.2 pounds annually. The most popular size of container was found to be 1 pint. Friday was found to be the busiest day of the week and December was the busiest month of the season for the sale of oysters.

PROPAGATION AND DISTRIBUTION OF FOOD AND GAME FISHES

The summary of output of fish and eggs from the various fish-cultural stations constitutes a source of gratification in that a new high record has again been established. The total of 7,570,482,300 shows an increase of almost 500,000,000 over the production for 1929. While the increase is very largely accounted for by an augmented output of marine forms, the eggs of which are available in tremendous quantities, there was also an increase in practically all the game varieties and certain of the other commercial forms. It is noteworthy that the production of most varieties was held close to previous levels despite a marked increase in the output of fingerling or larger fish, which require extended space and normally reduce the numerical output of the hatcheries. The output of fingerlings for 1930 was

250,170,300, representing an increase of practically 85 per cent over that of the previous year. The following tabulation indicates the production of the various groups of species:

Summary of output

Game species	205, 147, 000
Commercial species (interior waters)	524, 120, 900
Commercial species (anadromous)	304, 140, 100
Commercial species (marine)	6, 511, 367, 000
Miscellaneous species	25, 707, 300
Total	7, 570, 482, 300

While the above-mentioned increases were achieved partly through more intensive and efficient utilization of existing facilities, several new stations were placed in production. A limited distribution of trout and bass was obtained at the Crawford (Nebr.) substation. The new Valdosta (Ga.) and Fort Worth (Tex.) substations furnished miscellaneous warm-water fishes for distribution. During the year the substation located at Creede, Colo., was constructed and a stock of trout eggs secured for incubation, in addition to the operation of several field egg collecting stations using this point as a base.

During the fiscal year a steel distribution car with a capacity of 300 pails was completed by the builders.

The development of a new pond-cultural substation at Tishomingo, Okla., was initiated but owing to the destruction of a temporary dam by a flood no fish-cultural work could be carried on. The work of developing the bureau's fish-cultural plant in the Yellowstone Park has continued, with the completion of the hatchery building and living quarters.

PROPAGATION OF COMMERCIAL SPECIES

Marine species of the Atlantic coast.—The production of these stations accounts for the greater portion of the numerical output of the entire fish-cultural service. Increases were recorded over the previous year's production of winter flounder, while the cod and haddock figures are slightly below those of 1929. The distribution of 15,500,000 mackerel fry represents an expansion of work which has previously been carried on in a small way at the Woods Hole (Mass.) station. In connection with the work with all of the marine species it was possible to incubate the greater portion of the eggs, planting the fish in the fry stage and reducing the plants of eyed eggs.

Pacific salmon.—As a whole the output of the commercial species of Pacific salmon was materially below that for 1929. The only forms showing increased distribution were the humpback and steelhead salmons. In the consideration of these activities it should be borne in mind that there is a certain periodicity in the runs of Pacific salmon which accounts for marked fluctuations in the hatchery operations from year to year without signifying any particular decrease in the stock of fish. For example, 1930 was a "pink salmon" year in Puget Sound, increasing the distribution of humpback salmon or pink salmon from 1,852,000 in 1929 to 6,302,000 in 1930.

Anadromous species of the Atlantic coast.—In contrast with the very successful 1929 season with shad at the new Fort Humphreys (Va.) station, the 1930 output was virtually a total failure. While there

appears to have been a considerably reduced run of shad in the Potomac River, water conditions arising from prolonged dry weather apparently affected the normal spawning habit, so that practically no eggs were obtainable from the available run, which in good years has furnished from 50,000,000 to 70,000,000 eggs. The Fort Humphreys station had a normal season in the propagation of yellow perch. No striped-bass eggs were secured from the cooperative work with this species in North Carolina, probably for the same reason which affected the shad activities. The Craig Brook (Me.) station conducted the propagation of Atlantic salmon along the same lines as in previous years, although a larger percentage of the eggs was assigned to the Maine State hatcheries.

Commercial species of interior waters.—The important fishes included in this group were distributed in numbers showing a material increase over that of the previous year. Despite the fact that the bureau's Cape Vincent (N. Y.) and Put in Bay (Ohio) stations were able to secure whitefish eggs only in greatly reduced numbers, the aggregate production of whitefish for the entire group was over 50,000,000 in excess of that in 1929. The increase was almost entirely derived from the Michigan stations. An output of over 31,000,000 lake trout likewise indicates an increase over the previous year. The Michigan stations also contributed the bulk of this increase, the activities at the Duluth (Minn.) station having been sharply curtailed by a period of stormy weather at the height of the spawning season. The cisco or lake herring showed a very noticeable decline from the 1929 output. While the propagation of pike perch on Lake Champlain was conducted under weather conditions which materially reduced the output, the total production of this form for the entire group of stations was practically doubled. The Put in Bay station enjoyed a particularly successful year with this species. Average success attended the propagation of buffalofish and carp.

GAME FISHES

In reporting its game-fish distribution the bureau includes in this category only the trouts, landlocked salmon, and the warm-water pondfishes, comprising the basses, sunfish, crappie, catfish, pike, pickerel, etc. It is true that the pike perch, the lake trout, and the steelhead salmon are equally sought as game fish in many sections of the country. Inclusion of these varieties in the list of game species would consequently double or treble the output of this class. It is among the game fish hatcheries that the greatest expansion of facilities has occurred, and this expansion is reflected in an increased output of all forms excepting the black-spotted trout, smallmouth black bass, and the grayling.

In developing its program to become independent of all outside sources of egg supply the bureau has established several new collecting stations for eggs of wild trout in the Western States. The Meadow Creek (Mont.) auxiliary of the Bozeman (Mont.) station again eclipsed previous records with the Loch Leven trout, securing over 19,000,000. All station brood stocks of trout have been increased in number and the substation for the production of brook-trout eggs, located at York Pond, N. H., virtually doubled its output of the previous year. Of the total distribution of the game varieties

not more than 6,500,000 were distributed in the fry stage, the remainder comprising egg shipments or fingerling fish ranging up to legal size.

In spite of the fact that the cooperative nurseries created a new demand for close to 4,000,000 trout eggs and fry, the bureau has been able to keep practically up to date with the applications for trout. In many instances it has been possible to furnish greatly increased numbers of fish on the usual applications from territories adjacent to the hatcheries. In most cases average success has been attained in the propagation of warm-water varieties in the Southern States. The Fairport (Iowa) station provided a large number of bass for distribution as a by-product of its experimental work. The increased output for the previous year at the Orangeburg (S. C.) station has been maintained. The necessity of transporting rescued fish from the Mississippi River into Montana, Wyoming, South Dakota, and North Dakota was obviated by a splendid output from the Miles City (Mont.) substation, operated in conjunction with the State of Montana.

RESCUE OPERATIONS

After the inactivity of the previous year in the Mississippi River rescue field, natural conditions during the fall of 1929 were such as to permit of extensive operations and over 160,000,000 fish were handled. As usual, shipments on applications to other waters amounted to less than 1 per cent of the total number of fish handled.

COOPERATIVE ACTIVITIES

Wherever the bureau's activities have contact with those of other Federal bureaus or departments, mutually helpful relationships have been established. The Forest Service has furnished a detailed survey showing the requirements for restocking waters in all the principal national-forest areas as the result of conferences looking toward the development of a program for meeting these requirements. The National Park Service has worked with the bureau in closer harmony in connection with the creation of new hatcheries and rearing facilities in both Yellowstone and Glacier Parks. A bureau employee has been placed in full charge of all fish-cultural work in the parks and has been detailed to make surveys of all the important national-park areas for the purpose of working out a coherent stocking policy.

In view of the expansion of fish-cultural work in most of the States there has been a closer liaison between those agencies and the bureau. The propagation of commercial species in Michigan was particularly successful and the whole-hearted cooperation afforded by the State department of conservation contributed largely to these results. The State of Virginia is embarking upon an ambitious fish-cultural program and the bureau has been able to assist in various ways. The construction of an extensive bass-cultural establishment by the State of Arkansas has continued at a rapid rate under the direction of the bureau's superintendent at Mammoth Spring, Ark.

The work of restocking with both game and commercial species has been materially furthered by the harmonious relationships maintained with the States of Washington, Oregon, Wyoming, Minnesota, North Carolina, South Carolina, Maine, and others. With the coop-

eration of the Indian Service and the State of Nevada the bureau took over the fish-cultural work in connection with the propagation of black-spotted trout at Pyramid Lake. An employee of the bureau was detailed to participate in a survey of the inland hatcheries of the State of Ohio. Additional requests for assistance from a number of other States could not be fully met due to lack of facilities.

The cooperative nursery program whereby sportsmen's associations operating hatcheries or nursery ponds receive fish from the bureau's hatcheries for rearing to larger size has been standardized and constitutes a routine activity. During the fiscal year a few of the older nurseries discontinued operations for various reasons and additional ones were taken on, so that the total of 123 now conducted represents an increase of approximately 10 over the previous year. These organizations were furnished a total of 3,827,700 fish and eggs, largely of the trout species. In view of this heavy demand upon the bureau's trout production it has been necessary to exercise greater care in establishing new nurseries and to require that natural facilities be proper and adequate for the purpose. This has necessitated refusal to cooperate in some instances and termination of the cooperative arrangement already existing in others. Effort has been made to augment the number of bass nurseries and to extend the field of these operations into States and sections previously not touched to overcome the present "spotty" distribution in a few States.

In a number of States where the bureau conducts no cooperative nurseries the States are carrying on this work very successfully and there is little or no demand for the bureau's participation. Two of the establishments in New York and Pennsylvania are complete hatchery units incubating eggs and carrying on all the functions of a regular hatchery, with an employee of the bureau in charge.

It is believed that while the assignment of fish to individual nurseries may be decreased and the establishment of new units may fail to keep pace with the rate set during the earlier years, the output of large-sized fish will be materially increased by the standardization of procedure.

VESSEL NOTES

The *Albatross II* continued her scientific research work, with headquarters at Woods Hole, Mass. During the year the vessel was engaged in operations between Cape Ann, Mass., and Cape Hatteras, N. C., with the exception of one cruise between the continental shelf and Bermuda, which was discontinued on account of pump trouble developing. Oceanographic stations numbering 273 were made between Cape Ann and Cape Hatteras, varying in distance from a few miles to 180 miles offshore. At convenient times between cruises throughout the year the vessel underwent various repairs at the Boston Navy Yard. The vessel cruised 13,017 miles.

The steamer *Shearwater* was engaged in fish-cultural work at the Put in Bay (Ohio) station from November 1 to December 15 and from March 1 to June 1. In addition to this regular work she was engaged in fishery investigations on Lake Erie.

The steamer *Phalarope* was employed as usual as a tender at the Woods Hole biological station, except for a period of a few weeks in the spring when she was at the Fort Humphreys station on the Potomac, in connection with shad investigations.

The *Gannet*, *Plover*, and *Canvasback*, three boats which have been in the service of the bureau for approximately 25 years, have been condemned and will be disposed of. The *Gannet*, which was used at the Boothbay Harbor (Me.) station, is being replaced by a new vessel named the *Pelican*. This vessel is being constructed at Newport News, Va., and will proceed to the Boothbay Harbor station for duty. This new vessel is 78 feet in length, 10 feet 3 inches in depth, and 18 feet in breadth, with draft 5 feet. She is equipped with a 150 horsepower full Diesel, direct reversible engine.

Sixteen vessels of the Alaska service cruised more than 116,000 nautical miles in the fiscal year 1930. Of these, the *Crane* covered about 14,000 miles, the *Brant* 13,000 miles, and the *Teal* about 11,000 miles.

A new power vessel, *Penguin*, designed especially to serve as tender for the Pribilof Islands, was built at Seattle, Wash., and sailed on its initial voyage to the islands early in May. The *Penguin* is 130 feet in length and 27 feet in breadth and is of very sturdy construction to withstand the severe weather and ice conditions encountered at times in Bering Sea. Power is furnished by a 400-horsepower full Diesel engine. The *Eider*, formerly tender for the Pribilofs, was transferred to fisheries patrol work in the spring of 1930 and assigned to the Kodiak district.

Throughout the 1929 season the *Auklet*, *Murre*, *Petrel*, and *Widgeon* patrolled the fishing grounds of southeastern Alaska. Other vessels participated in the patrol of that district in the fall after their return from duty to the westward, as follows: *Crane*, which had been stationed in the Alaska Peninsula area and had also been used to transfer seasonal employees to and from Bristol Bay; *Teal*, which had maintained the patrol on Cook Inlet; *Scoter*, engaged on Bristol Bay; and *Kittiwake* employed in the Seward-Katalla district. The *Blue Wing* and *Red Wing* were used at Kodiak and Afognak Islands; the *Merganser* in the Ikatan-Shumagin district; the *Ibis*, at Chignik; and the *Coot* on the Yukon River. The *Brant* was engaged in general supervisory work and made one cruise westward as far as Unalaska.

In addition to work in connection with the conservation of the fisheries in Alaska, the *Brant* was engaged in a patrol of waters off Neah Bay, Wash., during the spring migration of the fur-seal herd, and the *Petrel* performed similar duty in the vicinity of Sitka, Alaska.

After the close of fishery activities in the fall, the *Brant*, *Crane*, *Teal*, *Eider*, *Kittiwake*, and *Scoter* sailed for Seattle, where they were given the necessary overhauling, and repairs were made in preparation for the next season's work.

APPROPRIATIONS

Appropriations for the bureau for the fiscal year aggregated $2,218,550, as follows:

Salaries	$823, 300
Miscellaneous expenses:	
Administration	4, 400
Propagation of food fishes	524, 000
Maintenance of vessels	152, 000
Inquiry respecting food fishes	108, 000
Fishery industries	53, 750
Protecting sponge fisheries	3, 100
Protecting seal and salmon fisheries of Alaska	370, 000
Upper Mississippi wild life and fish refuge	25, 000
For improvements at the La Crosse (Wis.) station	10, 000
Power vessel for Alaska fisheries	145, 000
	2, 218, 550

Very truly yours,

HENRY O'MALLEY,
Commissioner of Fisheries.

LIGHTHOUSE SERVICE

DEPARTMENT OF COMMERCE,
BUREAU OF LIGHTHOUSES,
Washington, July 1, 1930.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: In response to your request I furnish the following report upon the work of the service during the past fiscal year.

MORE IMPORTANT ACTIVITIES OF THE LIGHTHOUSE SERVICE DURING THE YEAR

An extensive project for improving aids to navigation in Lake Huron, near the Straits of Mackinac, was completed. This included the establishment of a modern light and fog-signal station on a submarine site at Poe Reef, marking the northerly side of the passage, and the establishment of a light and fog signal at Fourteen Foot Shoal, to mark the southerly side of the passage at its westerly end; also the establishment of a gas buoy off Cordwood Point, and other improvements. The Poe Reef and Fourteen Foot Shoal light and fog-signal stations take the places of the Poe Reef Lightship and the Cheboygan Point Light Station, and add materially to the safety of navigation, with a substantial reduction in the cost of maintaining aids in this locality. Work was in progress on the construction of a new light station at Detour, in Lake Huron, at the southerly entrance of the St. Marys River. The new light and fog-signal station at Lansing Shoal, Mich., was completed, having been in commission during part of the preceding fiscal year. The construction of an important light and fog-signal station at Anacapa Island, Calif., was in progress, and work was started on the construction of a primary light and fog-signal station at Cape Decision, Alaska.

Other important construction work in progress during the year included the improvement of aids at the approaches to the Cape Cod Canal, Mass.; the placing of steel-pile groins to protect the shore in the vicinity of Cape Hatteras light station, N. C., and the erection of a sea wall at Harbor of Refuge light station, Del.; new range lights at Tampa Bay, Fla., and at Boca Grande, Fla.; the establishment of a modern fog signal at the entrance to Southwest Pass, Mississippi River, La.; improvements in aids in Sabine Pass and the approach to Port Arthur Canal, Tex.; extensive repairs of hurricane damage in Porto Rico; and improvements in aids in the St. Marys River, Mich. The Livingstone Memorial Lighthouse, at Detroit, which was built by subscription, having been completed, lighting equipment was installed by the Lighthouse Service. Plans for a new depot at Portland, Me., were prepared, a site selected, and an agreement made for its purchase.

Four new lighthouse tenders were under construction during the year, two of which were completed and the other two nearly completed. Six new lightships were under construction; four of these were completed and delivered and the other two were nearly completed.

On June 30, 1930, there were 19,556 marine aids to navigation maintained by the Lighthouse Service, a net increase of 555. During the year 141 new automatic marine lights on fixed structures were established, and 93 lights were changed from attended to automatic. At the end of the fiscal year the total number of automatic marine lights on fixed structures was 1,714 (not including some partially automatic), and in addition there were 1,035 buoys with automatic lights, or a total of 2,749 in the Lighthouse Service.

The radiobeacon system was further extended, and the effectiveness and amount of service was increased during the year. Fourteen additional radiobeacons were established and 17 stations were under construction. The total number in operation at the end of the year was 78. Radiobeacons for the two approaches to the Panama Canal were installed during the year. Interference between beacons has been largely eliminated through synchronization of groups of signals and the use of different frequencies for adjacent groups. The hourly operation of radiobeacons has been extended, greatly increasing their usefulness. Charts showing information regarding radiobeacons were published.

Continued progress was made during the fiscal year in extending airways facilities. Lighting installation was completed on about 3,300 additional miles of airways including all or portions of the following routes: Brownsville-Fort Worth, Brownsville-Houston, Miami-Atlanta, Salt Lake-Great Falls, Washington-Cleveland, Albuquerque-Wichita, Atlanta-Chicago, Chicago-Twin Cities, Cleveland-Albany, Michigan, Milwaukee-Green Bay, New York-Montreal, Portland-Spokane, Salt Lake-Pasco, San Francisco-Seattle, and St. Louis-Evansville. Radio communication facilities were installed on approximately 2,500 additional miles of airways, and radiobeacon service extended over approximately 1,800 miles of airways. These additional facilities included 32 standard airways radio stations, 1 point-to-point airways radio station, and 2 airways radio range beacons. Twenty-six aural-type radio range beacons were under construction at the close of the year. As the result of a service trial of the teletype weather reporting circuit between New York and Chicago, this system of collecting weather information was adopted as standard. Telephone-typewriter circuits, aggregating 5,650 miles, were placed in official operation along civil airways for the purpose of transmitting weather reports from intermediate points to airway radio stations for broadcast to aircraft by radiotelephone. Airplane movements are also reported over these circuits. A total of 120 telephone-typewriter stations were placed in operation on the following circuits: New York-Cleveland, Cleveland-Chicago, Chicago-Omaha-Kansas City-St. Louis-Springfield, Omaha-Cheyenne, Cheyenne-Salt Lake, Salt Lake-San Francisco, San Diego-San Francisco, San Francisco-Portland, St. Louis-Cleveland, and Richmond-Boston.

Statements covering the works above mentioned in greater detail and including various other works in hand during the year are included under the appropriate heads following.

AIDS TO NAVIGATION

During the year various improvements in aids to marine navigation have been made. Twelve fixed lights were changed to flashing or occulting; the illuminant of 6 lights was changed to incandescent oil vapor; the illuminant of 36 lights (including 6 lighted buoys) was changed to acetylene; the illuminant of 23 lights (including 2 lightships and 1 lighted buoy) was changed to electric incandescent; 14 radiobeacons were established; and 4 diaphones and 4 oscillators and nautophones were established at important stations. The discontinuance of aids is under investigation from time to time as the original necessity for their maintenance ceases; 1,212 aids to navigation of various classes were discontinued. As previously reported, the total number of marine aids at the end of the year was 19,556.

In Alaska 41 new aids were established, and the total number is now 854, including 324 lights, 24 gas buoys, 2 float lights, 3 radiobeacons, 14 other fog signals, 309 buoys, and 178 daymarks.

The aids to navigation in the outlying United States territory of Guantanamo Bay, the American Samoan Islands, and the island of Guam are maintained under the supervision of the naval commandants by means of allotments made from appropriations for the Lighthouse Service.

At the close of the year there were approximately 13,500 miles of lighted airways in operation, with 319 intermediate landing fields, 1,477 airways beacons, 298 airways weather-reporting stations, 35 airways radio stations, 9 radio range beacons, 3 point-to-point airways radio stations, and, as stated before, 5,650 miles of telephone-typewriter circuits, including 120 telephone-typewriter stations.

In connection with the inspection of airways aids to navigation by airplane, it is planned to furnish each maintenance district with an airplane for inspection purposes, two such planes having been assigned to the superintendent of lighthouses, San Francisco, Calif., and to the airways engineer, Fort Worth, Tex. The airways division will also cooperate with the Coast and Geodetic Survey by furnishing an airplane and a pilot from time to time in survey work conducted by that service.

ENGINEERING CONSTRUCTION

The more important construction projects completed during the fiscal year stated in order of districts are as follows: A galvanized-metal storehouse at Edgemoor Lighthouse Depot, Del.; an acetylene light established at Bellevue Range Front, Del.; new roof installed on three bays of main storehouse, Portsmouth Lighthouse Depot, Va.; acetylene-gas lanterns installed on six structures in Back Creek, Md.; eight interlocking-steel groins built at Cape Hatteras Light Station, N. C.; a double dwelling for assistant keepers constructed and the keeper's dwelling and a storehouse remodeled at Jupiter Inlet Light Station, Fla.; range lights to mark cuts B and D completed at Tampa Bay, Fla.; extensive repairs carried out at several light stations in the seventh district made necessary by hurricane damage; the important light and fog-signal station at Southwest Pass, La., completed; repairs due to hurricane damage at several light stations in the eighth lighthouse district, including the wharf at Mobile Point Lighthouse, Ala.; the inclined roadway at Mona Island Light Station, P. I.; and

hurricane damage repairs at several stations in the ninth district completed; the important light stations in the Straits of Mackinac, Poe Reef, and Fourteen Foot Shoal completed and placed in commission; 12 acetylene-gas buoys installed in the Saginaw River, Mich.; reconstructing and improving the structures at the Michigan Island Light Station completed; three automatic lights and two gas buoys were established in Alaska; project for improving aids in the Columbia River completed; Grays Harbor Bar and Grays Harbor Entrance Range electrified.

Important works in active progress at the end of the fiscal year are as follows: Plans and specifications for a complete new depot at Portland, Me.; 11 structures for lights on Lake Okeechobee, Fla.; repairs to light stations due to hurricane damage in the ninth district; work of erecting 13 towers in the St. Marys River; plans for an important light station at Detour, Mich.; site graded, dock and tramway constructed, and camp buildings erected for light and fog-signal station at Cape Decision, Alaska; plans for construction of a wharf and warehouse for a lighthouse depot at Seattle, Wash.; plans for constructing a flashing acetylene light at Bush Point, Wash.; a concrete warehouse and machine shop of same material at Goat Island, Calif.; preliminary work for important light station on Anacapa Island, Calif.

IMPROVEMENTS IN APPARATUS AND EQUIPMENT

The extension of commercial power lines, the design of dependable small generators, and the increased number of radiobeacon installations have made it practical and economical to increase further the use of electricity for furnishing the current for lights and power to operate sound signals and other light-station equipment. Minor electric lights in considerable number have been installed in which the current for the lamp and for the operation of the flashing mechanism is furnished by several primary cells or dry cells. In displacing oil lanterns by this apparatus the cost of maintenance is practically eliminated, and on the acetylene lights the cost of equipment reduced about $175. The primary electric outfits can be furnished complete for about $55 each. Experimental installations of such flashing lights are being tested on buoys also, with a view to their more extended use where practicable.

Considerable study is still being given to the proper electric light for rapidly revolving lenses and for lightship lanterns. Improvements in the present electrical equipment on several lightships have been made and others are projected. Interesting experiments are under way to improve further the light from the masthead of lightships by increasing the divergence of the beam. At several light installations where storage batteries are provided for auxiliary electric-current supply, a relay system has been devised to cut in and out automatically the rectifier charging the battery.

Three light stations in the service are now equipped with wind-electric plants for furnishing current. At Kalae Light Station, Hawaiian Islands, because of the almost constant winds it has been found practicable to give the battery a lower charging rate, and keep it in an almost charged state.

During the year equipment was provided to replace all obsolete spark transmitters on lighthouse tenders with the latest type tube or

modulated continuous wave transmitters, in compliance with the 1927 International Radio Conference. Further improvement in the design of transmitters to provide greater frequency stability, as well as compactness and ruggedness for service on lightships, has been made. A continuous wave transmitter was permanently installed at Cape Henry Lighthouse for observation and test as opportunity permits. Tests of last year indicate that the design and the principle are feasible pending the modernizing of existing ship's radio compasses. A special low-power radiobeacon transmitter was also developed for use at harbor approaches and at points of lesser importance. These transmitters were designed to operate on 60-cycle alternating current and to emit signals at any one of five tones from 400 to 1,600 cycles.

This differentiation of tone will be tested as a third method of distinguishing between radiobeacon stations, in addition to characteristic and frequency. Over 30 transmitters of this type were built and installed during the year. A policy was adopted to operate all radiobeacons, with minor exceptions, for a definite period each hour during clear weather, this being made possible by the development of successful clock control and automatic operation. This is being carried out as rapidly as the equipment can be installed. In this connection an alarm system, which will inform the keepers of any failure of the automatically operated radiobeacons during the operating period, has been developed with very satisfactory results.

Two more isolated stations in the service were interconnected and placed in touch with the shore through the installation of radiotelephones of low power. These installations are proving very valuable in the efficient operation of the stations and are also a potent factor in keeping up the morale of the personnel.

Synchronized radiobeacon and sound-in-air signals, similar to the installation at Cape Henry in 1929, have been installed at five other stations and are being further tested. By this means the navigator is able to determine his distance from the station at any time when he can hear the signal.

A further test was conducted during the year of a system previously developed of remote control of fog signal by radio. The device has been permanently installed at an important station and is in constant use to control the operation of a fog signal at a near-by station. This apparatus makes it practicable to place an efficient minor fog signal out at the point of danger and control it from shore.

A number of fog signals of the vibrating-disk type are in commission, and these types of signals are being further investigated. The replacement of worn-out steam fog-signal plants with more modern equipment has been continued during the year. At Manitou Island Light Station the diaphone fog signal has recently been fitted with two resonators, a vertical mushroom horn and a long flared horizontal horn. Alternate blasts are sounded on each; the signal from the mushroom horn for all directions of the compass, and from the long-flared horn for maximum audibility in the direction of the most used shipping lane.

A number of acetylene-gas buoys having tanks within the open body of the buoy were converted to provide pockets for the tanks individually with capacity for little more than the tank itself, thus avoiding opportunity for a dangerous accumulation of gas within a large inclosure in the event of a leak, a serious accident having

resulted during the year from this cause. The piping of many gas buoys has also been changed so that all portable gas connections can be made outside the buoy body. Whistling buoys are being equipped with the improved type valve referred to in the last report. The replacement of wooden-spar buoys by the special type steel buoys is being steadily extended.

The important lighthouse at Navassa Island has been made completely automatic, effecting a yearly saving of about $7,500.

A new type of die-lock chain for lightship moorings has been under test during the last year with satisfactory results.

The use of automobile trucks for servicing land stations and for carrying on other district work has been extended.

Development of equipment for use on lighted airways is being continued. Further improvement was obtained in the illumination of the standard wind cone through the use of a full parabolic reflector installed in the base of the cone. A new motor-driven sign flasher was designed utilizing cam-operated mercury tubes for obtaining desired code flashes. Amber lenses on course lights installed at intermediate fields were discontinued and green adopted as the standard color. Further refinements were made in the astronomic dial time switch. Improvements were made in the standard control cabinets. A ventilator system was developed for the standard-code beacon, so that 500-watt lamps can be used as light sources without undue heating of the 300 m/m Fresnel lenses for use as the standard auxiliary airport beacon. Arrangements were made for the use of a monoplane filament instead of the semibarrel type used heretofore in the standard 1,000-watt, 110-volt, T–20 beacon lamp, reducing the aviation lamps to a single standard for all purposes. Service tests were made of 3KVA single-phase full-automatic engine-generator sets for use at sites where commercial current is not available and where distances between power plants and beacons require transmission of power at high voltages.

JURISDICTION OF THE LIGHTHOUSE SERVICE

The United States Lighthouse Service is charged with the establishment and maintenance of aids to navigation and with all equipment and work incident thereto on the sea and lake coasts of the United States, on the rivers of the United States so far as specifically authorized by law, and on the coasts of all other territory under the jurisdiction of the United States, with the exception of the Philippine Islands and Panama. The total length of coast line and rivers under the United States Lighthouse Service, measured by steps of 3 miles, is approximately 40,635 statute miles.

ADMINISTRATION

The general organization of the service remained unchanged throughout the year.

The extension of automatic apparatus for operating lights was continued, also the grouping of minor lights under the care of fewer attendants and the discontinuance of unnecessary aids where practicable. There was a saving in maintenance resulting from the replacement of the Poe Reef Lightship with a fixed structure.

The total appropriations for the maintenance of the Lighthouse Service for the fiscal year 1930 was $9,719,980 and for special works $1,911,000, of which amount $81,000 was a deficiency appropriation for hurricane damage. These amounts are exclusive of appropriations for airways, in the total sum of $5,533,320, of which $5,367,370 was allotted the airways division, Lighthouse Service.

Systematic inspections of the service, both on its technical and business sides, were continued during the year, including stations, vessels, depots, etc.

Cooperation with other branches of the Government service has been continued. The personnel on vessels and at stations are encouraged to render aid to those in distress, and many cases of assistance and rescues at sea have occurred during the year. The Lighthouse Service has cooperated with the Census Bureau in making disbursements for the current decennial census.

The Lighthouse Service sent an exhibit to the Seville Exposition, consisting of a large map of New York Harbor, showing aids to navigation; also a model of Kilauea Point Lighthouse in the Hawaiian Islands and a number of mounted photographs. A diploma of honor was awarded this service.

Radiobeacon charts have been published by this service for distribution to navigators and others interested, covering the North Atlantic coast; the Pacific coast, with Alaska and the Hawaiian Islands; the Great Lakes; and North America. These give details as to all radiobeacons within these areas maintained by the United States as well as by Canada.

The President appointed H. D. King, superintendent of lighthouses, fifth district, to be Deputy Commissioner of Lighthouses, to succeed John S. Conway, who was retired.

An International Lighthouse Conference, the first that has been held, took place in London in July, 1929, at which the United States was represented by Commissioner Putnam and by Superintendent Yates and Superintendent Rhodes. This conference, which included representatives of the lighthouse authorities of 24 countries, was informal, its purpose being the exchange of information and the discussion of problems affecting lighthouse systems.

A new accounting system has been installed in the twelfth and fifth districts. These installations were made as tests of a uniform system of accounting for the Government service, designed by the General Accounting Office; it is proposed to make similar installations in other district offices as early as practicable. The new system has also been introduced in the bureau's office in Washington.

A pamphlet of working instructions was prepared for certain units of the airways division of the Lighthouse Service, including portions of the Instructions to Employees of the Lighthouse Service, with further instructions specially applicable to the airways work.

The act of June 24, 1930, provides that light keepers and vessel officers and crews, who during their active service were entitled to medical relief at hospitals and other stations of the Public Health Service, may be given such relief after retirement as is now applicable to retired officers and men in other branches of the Government service, under joint regulation to be prescribed by the Secretary of the Treasury and the Secretary of Commerce.

The act approved June 18, 1930, authorized the purchase of a site for a lighthouse depot near Seattle, Wash., the purchase of additional land for the depot at Chelsea, Mass., and also extended previous authorizations of depot sites to include Narragansett Bay, and the vicinity of Rockland, Me. This act also provides for the transfer of the old lighthouse at Cape Henry, Va., to the Association for the Preservation of Virginia Antiquities.

The closing of navigation last fall on the Great Lakes was marked by unusually severe storms and cold weather, which greatly interfered with the work of removing buoys, and did some damage to aids to navigation. The Narrows Light Station, in Boston Harbor, was destroyed by fire on June 7, 1929.

PERSONNEL

On June 30, 1930, there were 5,704 persons employed in the marine work of the Lighthouse Service. This is a reduction of 69 from the number in 1929 and 316 from the maximum number in 1923.

Although there has been a steady increase in the number of aids to navigation maintained, the increasing use of automatic apparatus has made it possible to effect a net reduction of 7 keepers and 31 light attendants and lamplighters during the year.

The number of persons in the airways division on June 30, 1930, was 1,579, making a total of 7,283 for both branches.

The United States Employees' Compensation Commission gives the number of reported cases of injury subject to compensation for the calendar year 1928 of employees of the Lighthouse Service as follows: Cases resulting in death, 3; cases resulting in permanent total or partial disability, 5; cases of temporary total disability, 146.

Three employees were killed by an explosion on a lighthouse tender and there was one case of accidental death by drowning during the fiscal year. There were 315 casualties during the same period resulting in more or less serious injuries of employees on vessels and at light stations, etc.

Incidental to the regular work of the service, many opportunities arise for rendering aid to those in distress because of the location of light stations and vessels. During the fiscal year about 113 instances were reported of saving life and property or rendering valuable aid, often at great risk to the Lighthouse Service employees. Many of these acts were especially meritorious, and some of the employees were specially commended by the Secretary of Commerce, and in one outstanding case (the rescue of a drowning woman by a seaman on a lighthouse tender), the matter was brought to the attention of the Secretary of the Treasury with recommendation that the rescuer be awarded a life-saving medal in recognition of his bravery.

LIGHTHOUSE DEPOTS

During the fiscal year important improvements were carried out at several lighthouse depots. At Edgemoor, Del., a galvanized metal storehouse 40 feet wide by 82 feet long was erected for housing the district stores. Plans have been approved to remodel the present foundry at the lighthouse depot, Staten Island, to provide a carpenter shop, and to move the present machine shop from the old building into the carpenter shop, connecting the two buildings by a viaduct.

At Portsmouth Lighthouse Depot the old wooden-trussed roof over three large bays of the main storehouse was removed and replaced with steel roof framing covered with a corrugated protected metal roof. A reinforced concrete warehouse and machine shop are under construction at the Goat Island Lighthouse Depot, Calif. At Honolulu Lighthouse Depot, Hawaii, a reinforced concrete storehouse and shop building and an oil house were built.

New depots are under consideration near Rockland, Me., and in Narragansett Bay. The purchase of additional land to extend the site of the lighthouse depot at Chelsea, Mass., has been authorized. At South Portland, Me., a site has been purchased where the principal depot of the first district and the district office will be located. Building plans are being prepared. Preliminary plans have been prepared for a depot at Salmon Bay, Seattle, Wash.

VESSELS OF THE LIGHTHOUSE SERVICE

The Lighthouse Service at the end of the fiscal year had in commission 112 vessels. The situation as to the replacement of obsolete and old vessels has been greatly improved. Five new lightships and two tenders have been completed during the year. Two tenders are being constructed under contract, which will result in the replacement of lightships *No. 1*, *No. 5*, *No. 13*, *No. 41*, *No. 67*, and *No. 70*, and the tenders *Poinsettia*, *Water Lily*, *Laurel*, and *Holly*. These vessels are beyond economical repair for this service.

LIGHTHOUSE TENDERS

Plans have been prepared for a new steel tender to replace the small wooden tender *Birch* which is beyond economical repair. Preliminary plans have been started for two new tenders for the eighth district. A new tender is also needed for the third district to replace the tender *Pansy*.

The tender *Sundew* was transferred from the seventh district to the tenth district and assigned to duty on Lake Ontario, and the tender *Elm* was transferred from the third to the eleventh district.

Lighthouse tenders during the year steamed a total of 502,048 miles in the various maintenance, construction, and inspection work, an average of approximately 9,128 miles for each tender. The total quantity of fuel consumed by tenders during the year was 66,501 tons of coal, 90,457 barrels of fuel oil, 16,406 gallons of gasoline, and 1,810 gallons of kerosene. The total cost of maintenance of tenders during the year was $2,303,816, exclusive of repairs which cost $404,491.

The new tender *Althea*, which replaced the tender *Water Lily*, and the new tender *Poinciana*, which replaced the tender *Poinsettia*, destroyed by explosion, were completed, the former being placed in commission during the fiscal year.

New Scotch boilers were installed in the tender *Hibiscus*.

The tender *Palmetto* was converted to Diesel-engine propelled, resulting in greater economy of operation.

The tender *Ivy* was converted to an oil burner during the year, resulting in an increased steaming radius and other economies.

At the end of the year 55 tenders were in commission, 3 of which were undergoing repairs; of these 21 have radiocompasses and 31 have radio communication.

The following tenders have been extensively overhauled during the year: *Ivy*, *Hibiscus*, *Kukui*, *Sunflower*, *Magnolia*, *Cypress*, *Mayflower*, *Iris*, and *Anemone*.

The following was the number of tenders of the Lighthouse Service in commission on June 30 of the years specified, omitting vessels not having regular crews: 1910, 51; 1915, 45; 1920, 55; 1925, 55; 1926, 56; 1927, 57; 1928, 56; 1929, 55.

There are 10 small depot tenders without regular crews.

The tender *Water Lily* was condemned, after being found beyond economical repair, and was sold July 2, 1930, for $401.

LIGHTSHIPS

Lightships are maintained on 44 stations. At the end of the year 57 lightships were in commission, including 13 relief ships. They averaged 262 days on station per vessel. The total cost of maintenance of lightships during the year was $1,112,254, exclusive of repairs, which cost $212,730.

The lightship station at Poe Reef, Mich., was discontinued August 15, 1929, on the completion of the new light and fog-signal station, and the lightship (*No. 99*) was then transferred to the twelfth district. Lightship *No. 98* was transferred from the twelfth to the second district.

Three of the six new Diesel electric-propelled lightships building under contract were completed during the year; the first, *No. 100*, was placed in commission on Blunts Reef Station, Calif., on February 10, 1930. The second, *No. 113*, was placed on Swiftsure Bank Station, Wash., on June 15, 1930. The third, *No. 115*, for Frying Pan Shoals, N. C., was placed on station July 15, 1930.

The following was the total number of lightships on June 30 of the years maintained: 1910, 68; 1915, 66; 1920, 62; 1925, 59; 1926, 56; 1927, 57; 1928, 56; 1929, 55; 1930, 57. Lightship stations: 1910, 51; 1915, 53; 1920, 49; 1925, 46; 1926, 46; 1927, 45; 1928, 46; 1929, 45. Of the present lightships 44 have self-propelling machinery, 11 are provided with sail power only, and 2 have no means of propulsion.

Lightship *No. 70* was condemned, after being found beyond economical repair, and was sold on May 21, 1930, for $710.

Very truly yours,

GEORGE R. PUTNAM,
Commissioner of Lighthouses.

COAST AND GEODETIC SURVEY

DEPARTMENT OF COMMERCE,
COAST AND GEODETIC SURVEY,
Washington, July 1, 1930.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: In response to your request I furnish the following report upon the work of the bureau during the past fiscal year.

HYDROGRAPHIC AND TOPOGRAPHIC WORK

During the fiscal year 1930, hydrographic, topographic, and control surveys were made along various sections of the Atlantic, Gulf, and Pacific coasts, including Alaska, Hawaiian Islands, and the Philippines. To perform these surveys, which comprise 41 separate projects, 27 survey units were employed.

A brief summary of the surveys accomplished or in progress at the close of the year is given below:

Atlantic coast.—The necessary surveys were completed to make possible the construction of two new general charts between Cape Canaveral and Jupiter Inlet, Fla. These charts, Nos. 1246 and 1247, will replace Nos. 162 and 163 of the old series. In connection with this project the ground control necessary for the reduction of air photographs was established and the new charts will include the phototopography. The work on this project was accomplished by the parties on the *Lydonia*, *Ranger*, and *Natoma*.

From July to November the parties on the *Lydonia* and the *Ranger* were engaged on new surveys off the Delaware and Maryland coasts. This work extended offshore to the edge of the continental shelf and represents part of a general resurvey of the section of the coast lying between the Delaware and Chesapeake Bays. Air photographs have also been recently taken of this region and the necessary ground control was established for that section along which the parties worked. During this same period the party on the *Natoma* made several surveys in Chesapeake Bay necessary in the investigation of reported changes in the charts.

The first assignment of the *Oceanographer*, which was acquired in January, was on the Gulf coast of Florida. Work was started here on a comprehensive survey of the region east of Pensacola. This project was discontinued in May in order to take up work with the *Lydonia* on Georges Bank during the summer months. Work will be continued on the Gulf project during the winter.

A wire-drag survey of Long Island Sound was started near the end of the fiscal year. The necessity for this work has been recognized for several years, but it was not until this year that funds have been available. A wire-drag examination was made of a reported shoal area in the vicinity of Ambrose Lightship.

Inland waterway surveys were made in Chesapeake Bay, in Lynnhaven Roads, Norfolk Harbor, Elizabeth River, Va., and in St. Andrews Bay, Fla.

A field examination was made of Delaware and Chesapeake Bays for a revision of the Atlantic Coast Pilot, Sandy Hook to Cape Henry. An examination was also made of the inland route through New Jersey for a new edition of the Inside Route Pilot, Coast of New Jersey.

A party in the launch *Elsie* made an examination of the inside route from Charleston, S. C., to New York.

Owing to the increased interest in yachting, the demand for information concerning the inside route from New York to Key West has materially increased. There has also been a big increase in the sale of Coast Pilots covering the coast from St. Croix to Sandy Hook. This is also probably accounted for by the increased demands of the yachtsman.

Pacific coast.—Complete new offshore surveys were extended along the California coast from the vicinity of Cape Mendocino southward to Pigeon Point by the parties on the ships *Discoverer* and *Pioneer*. The same parties also completed the inshore work except for the section between Bowens Landing and Point Reyes and between Halfmoon Bay and Pigeon Point. Work on the former of these two sections was taken up near the end of the fiscal year by an independent party using the chartered launch *Rogue*.

The party on the ship *Guide* having returned from a 2-year assignment in the Hawaiian Islands took up, near the end of the fiscal year, an extensive project on the Washington coast. This consists of complete new offshore and inshore surveys from a junction with previously completed work in the vicinity of Cape Elizabeth northward to Juan de Fuca Straits. The control was established and the topographic work completed for a considerable portion of this project earlier in the fiscal year by an independent shore party.

The party on the motor vessel *Westdahl* took up, as the first assignment of this new vessel, complete new surveys in Santa Barbara Channel and completed the work contemplated in time to join the *Discoverer*, as a tender, for work in southwest Alaska.

A party using the chartered launch *Rogue* completed topographic and inshore hydrographic surveys inside of completed offshore work from the vicinity of Crescent City southward to Cape Mendocino. This project also included a wire-drag survey of the anchorage in, and the approaches to, Crescent City Harbor, as well as revision surveys in Humboldt Bay.

Two parties were engaged during several months of the year in extending new schemes of coastal triangulation for the control of hydrographic and topographic surveys between Cape Mendocino and Rockport and between Point Reyes and Fort Bragg, the intermediate section between Rockport and Fort Bragg having been accomplished earlier in the year by subparties from the ship *Discoverer*.

Alaska.—The party on the ship *Surveyor* accomplished a large amount of field work along the northwest and west coasts of Kodiak Islands. Detailed surveys were made of Zachar, Spiridon, Larsen, Uganik, South Arm, Alitak, and Deadman Bays, as well as that

portion of Shelikof Strait which had not been adequately surveyed. During the present season the *Surveyor* is continuing operations on the west coast of Kodiak Island. Its season's work will include a complete and detailed survey of Sitkinak Strait. The results of the surveys around Kodiak Island will be published on new charts on a scale of 1 to 80,000.

The party on the ship *Discoverer* is engaged during the present season in making new surveys along the south coast of the Kenai Peninsula between Aialik Bay and Chugach Islands. These will include detailed surveys of Nuka Island Pass, Port Dick, and Windy Bay and will furnish the data for the construction of new and more detailed charts of that locality.

The party on the ship *Explorer*, cooperating with the United States Army Engineers and with the United States Lighthouse Service, accomplished a new survey of Wrangell Narrows. This project included the location of all the permanent aids to navigation in the narrows and the extension of surveys through Beecher Pass and Duncan Canal southward into and along the north coast of Sumner Strait as far west as Mitchell Point. This party also completed the surveys necessary to obtain data for the construction of large-scale charts of Keku Strait and extended control surveys from that locality southward along the west coast of Sumner Strait. During the present season the party on the *Explorer* is engaged in obtaining the data necessary for the construction of larger-scale charts of Behm Canal and its tributaries. Demands for such charts have increased with the proposed extension of steamer routes to include these scenic passages.

During the past year three connections were completed between the first-order scheme of triangulation through southeast Alaska and the Alaska-Canada boundary triangulation. These connections, which rigidly fix the Alaska-Canada boundary on the North American datum, were made through Taku Inlet, Stikine Strait, and Behm Canal.

Hawaiian Islands.—The party on the ship *Guide* (July to September) and the party on the ship *Pioneer* (April to June) continued work on the project which calls for a survey of the entire region between the main group of the Hawaiian Islands and Midway Island. This area, embracing a chain of shoals, reefs, and islets, which have never been properly charted, is over 2,000 miles in length and parallels the main steamship tracks between Honolulu and the Orient. The new charts resulting from the detailed surveys being made will undoubtedly shorten the steamship tracks and effect considerable saving in time and expense to trans-Pacific shipping. More than 50 per cent of this project had been completed at the end of the fiscal year. During the month of September the party on the *Guide* made detailed surveys of the anchorages and approaches to Honuapo and Punaluu, Island of Hawaii, to meet the demands for large-scale charts of these roadsteads.

Philippine Islands.—The parties on the ships *Pathfinder*, *Fathomer*, and *Marinduque* continued work throughout the year in the following localities: North and east coasts of Luzon Island; south coast of Palawan Islands; Tawitawi Island, Sulu Archipelago; south coast of Mindanao Island.

Hydrography, topography, and triangulation (second and third order) performed during year

Locality	Hydrography			Topography		Triangulation (second and third order)		
	Miles of sounding lines	Area, in square miles	Number of soundings	Length of shore line surveyed, in miles	Area surveyed, in square miles	Length of scheme in miles	Area covered, in square miles	Number of geographic positions determined
Georges Bank, Mass	863	900	2,460					
Entrance to Ambrose Channel, N. Y.	3	1	140					
Cape Henlopen to Fenwick Island, Del. and Md	823	85	18,604					
Lewes to Ocean City, Del. and Md	1,148	1,235	13,512	49	11	10	10	12
Chesapeake Bay, Md. and Va	669	52	16,177	25		20	26	24
District of Columbia					1			
Little Creek and vicinity, Va	100	2	10,233	23	7	8	49	26
Norfolk, Va	158	8	8,971	128		14	14	33
Cape Canaveral to Sebastian, Fla	2,543	653	29,879	37	9	40	89	50
Sebastian to Fort Pierce, Fla	2,054	1,118	62,645	50	9	10	35	38
Fort Pierce to Jupiter Inlet, Fla	2,910	766	50,859	39	1	36	95	59
East coast of Florida (air photo reduction)				574	752			
Shark River and Whitwater Bay to Naples, Fla	1,413	137	55,744	5	2			
St. Andrews Bay, Fla	181	9	7,655	31	8	5	5	7
East of Pensacola, Fla	237	47	5,265	15	3	12	17	9
Santa Barbara Channel, Calif	1,612	564	6,448					17
Point Reyes to Pigeon Point, Calif	7,277	4,380	57,206	68	46	7	35	9
Point Arena to Point Reyes, Calif	6,847	6,309	42,244	81	20	6	5	10
Gualala, Calif	89	7	1,755	11	4			
Point Reyes to Fort Bragg, Calif						108	250	150
Rockport to Punta Gorda, Calif						60	128	98
Crescent City to Cape Mendocino, Calif	734	113	25,989	187	69			
Cape Elizabeth to Cape Johnson, Wash				59	115	42	115	18
Cape Elizabeth to Destruction Island, Wash	1,044	225	10,113					
Behm Canal and Stikine River, Alaska						64	188	132
Behm Canal, Alaska	864	79	20,258	154	56	35	96	35
Taku Inlet and Stikine River, Alaska						36	203	21
Wrangell Narrows, Duncan Canal, and Sumner Strait, Alaska	1,231	74	40,406	79	24	58	106	171
Kenai Peninsula, Alaska	1,452	977	8,032	45	14	37	231	41
Kodiak Island, Alaska	3,951	1,578	51,736	224	315	60	157	81
Do	2,068	980	16,932	61	36	78	471	84
Oahu, westward and vicinity of Hawaii, Hawaiian Islands	11,289	48,654	28,901	8	1		1	2
Oahu Island to Gardner Island, Hawaiian Islands	6,820	42,600	21,760					
North of Luzon and Mindanao, P. I.	7,200	6,409	41,504	66	90	71	1,025	18
East coast of Luzon and Palawan, P. I.	1,349	1,076	20,429	93	235	46	300	19
Sulu Archipelago and Mindanao, P. I.	4,504	1,361	104,192	161	85			
Total	71,433	120,399	780,049	2,273	1,913	863	3,651	1,164

GEODETIC WORK

[July 1, 1929, to June 30, 1930]

	Length of scheme	Area covered
Triangulation, first-order:		
New York, Pennsylvania, and New Jersey, Buffalo-Trenton arc	*Miles* 325	*Sq. mi.* 3,450
Illinois, Missouri, Kentucky, Arkansas, Tennessee, Mississippi, and Louisiana, Mississippi River arc	615	4,900
Georgia, Alabama, and Mississippi, Atlanta-Shreveport arc	340	4,300
California, Bear Lake to thirty-fifth parallel arc	105	2,000
California, Point Reyes to Great Valley	45	1,450
Total	1,430	16,100
Traverse, first-order:		
Louisiana, LaBarre to Torras	23	-------
Louisiana, Kentucky, and Arkansas, connections to Mississippi River Commission stations	10	-------
Total	33	-------
Base lines, first-order:		
Ohio, Portsmouth	5.3	-------
California, Lucerne Valley	8.7	-------
New Jersey, Princeton	5.3	-------
Pennsylvania, Knoxville	3.8	-------
Missouri, East Prairie	10.3	-------
Mississippi, Stovall	7.2	-------
Arkansas, Chicot	5.8	-------
Louisiana, Mounds	5.4	-------
Louisiana, New Roads	6.8	-------
Louisiana, Gramercy	7.5	-------
Louisiana, New Orleans	4.7	-------
Missouri, Rogersville	12.1	-------
Iowa, Corydon	5.0	-------
Total	87.9	-------
Reconnaissance, first-order triangulation:		
Pennsylvania and New Jersey, Canton to Trenton	*Miles* 160	*Sq. mi.* 2,260
Iowa and Nebraska, forty-second parallel arc	175	2,100
Wisconsin, La Crosse to Fond du Lac	140	1,500
Illinois, Cairo to thirty-ninth parallel arc	110	1,440
Missouri, Cairo to Charleston	20	180
Illinois, Kentucky, and Tennessee, Cairo to Nashville	160	1,700
California, Lucerne Valley to thirty-fifth parallel arc	75	1,600
California, Point Reyes to Great Valley	45	1,450
Total	885	12,230
Leveling, first-order:		
Taylor Springs, N. Mex., to Pueblo, Colo., in progress at the beginning of the fiscal year (162–14=148)	148	-------
Colorado Springs to Denver, Colo	80	-------
Colorado Springs to Cheyenne Wells, Colo., 171 miles of single line	86	-------
Philadelphia to Harrisburg, Pa	117	-------
Shelbyville to Vincennes, Ind	149	-------
Washington to Petersburg, Ind	16	-------
Wabash to Huntington, Ind	19	-------
Washington to Indianapolis, Ind	112	-------
Total	727	-------
Summary:		
First-order triangulation	1,430	16,100
First-order traverse	33	-------
First-order base lines	87.9	-------
First-order triangulation, reconnaissance	885	12,230
First-order leveling	727	-------

It can be seen from the preceding table that a large part of the control surveys executed during the fiscal year 1930 were in the eastern half of the United States. This is in accordance with the statement made in the 1929 report that additional arcs of triangulation would be extended in the eastern part of the United States during the fiscal years 1930 and 1931, in order to adjust the triangulation in that region in one unit, in a manner similar to that of the western adjustment made three years ago. When completed, the two adjustments will give all triangulation stations in the United States permanently fixed geographic positions to which all future surveys will be coordinated. It seems certain that the triangulation necessary for the eastern adjustment will be completed in the fiscal year 1931.

The important arc along the Mississippi River was executed at the request of the Corps of Engineers of the United States Army and under financial cooperation with that organization. The purpose of this arc is to serve as a basis for the detailed topographic and flood-control surveys along the river. It also forms a part of the network of first-order triangulation over the eastern half of the United States.

A double observing party was used on the Mississippi arc and excellent progress was made in spite of difficult terrain, poor roads, and exceptionally high trees. The arc extends from Cairo to New Orleans, a distance of 615 miles, and was completed in six months. Connections were made at intervals of approximately 15 miles to stations of the Mississippi River Commission in order that the old surveys could be coordinated with the new ones. Because some of the stations were difficult to recover and almost inaccessible, five of these connections were made by traverse.

Another important arc of first-order triangulation was the one extended across New York and Pennsylvania, from Buffalo, N. Y., to Trenton, N. J. This divided a large loop of the eastern network of triangulation into two smaller loops, in preparation for the adjustment of the triangulation of the eastern half of the country. A double observing party was used on this arc also.

On both of the arcs mentioned above the Bilby portable steel towers were used. The Mississippi River arc was an especially severe test of the towers, as the high trees made necessary an average height of tower of 126 feet, and at one station a height of 156 feet was used.

In connection with earthquake studies in California two arcs of triangulation were completed in that State. In order to have the stations rather close together in the fault zones, where the larger earth movements are likely to occur, each of the arcs is a combination of a large first-order scheme with a smaller connected second-order scheme running through it. This gives exceptionally accurate positions for the stations near the faults, and it should be possible, in the future, to detect rather small earth movements by reobserving the triangulation after the lapse of several years or following an earthquake in the region.

Thirteen bases were measured during the year, of which 7 were along the Mississippi River arc of triangulation, 2 on the ninety-third meridian arc, 2 on the Buffalo-Trenton arc, 1 in California, and 1 in Ohio near the southern end of the first-order arc extending from the thirty-ninth parallel to Lake Erie. The observations for horizontal directions on the last-named arc were completed early in the fiscal year 1930.

In preparation for an unusually extensive program of triangulation for the fiscal year 1931, reconnaissance surveys were made over several projected new arcs of triangulation, mostly in the eastern half of the United States. One of these arcs is along the forty-second parallel from the ninety-eighth meridian to a point south of Chicago, one is an east-and-west arc across the central part of Wisconsin and three of them are short arcs radiating north, east, and west from Cairo, Ill.

A number of Laplace stations needed for the eastern adjustment were provided by an astronomical party which made observations for longitude, azimuth, and latitude in eight States in the northern part of the country, east of the Mississippi River.

About 725 miles of first-order leveling were run during the year. Two lines were run in Colorado, one in Pennsylvania and four

rather short lines in Indiana. The work in Indiana was requested by the Corps of Engineers of the United States Army, for use in flood-control operations, and was financed from flood-control funds.

Only one gravity party did field work during the year. Six stations were occupied in the Bahama Islands and one in Florida, in cooperation with the international expedition to the Bahamas under the auspices of Princeton University.

The international variation of latitude station at Ukiah, Calif., was continued in operation during the year.

MAGNETIC AND SEISMOLOGICAL WORK

Magnetic stations occupied during the fiscal year

Alabama	5	Montana	2
Alaska	23	Nebraska	6
Arizona	5	New Hampshire	1
California	21	New Jersey	1
Colorado	2	New Mexico	4
Connecticut	2	New York	5
Delaware	2	North Dakota	6
Florida	4	Oregon	1
Hawaii	9	Pennsylvania	2
Kansas	9	Philippine Islands	3
Maine	5	Texas	10
Maryland	4	Wyoming	1
Massachusetts	3		
Minnesota	5	Total	141

The primary object of the year's magnetic work has been the occupation of repeat stations in order to determine the change of the earth's magnetism with lapse of time. The special aim has been to complete during the calendar year 1930 the secular change data covering the period 1925–1930 needed to prepare the publication entitled, "Magnetic Declination in the United States in 1930." Incidentally, a considerable number of stations which had ceased to be available have been replaced to meet the needs of local surveyors.

Continuous photographic records of the variations of the magnetic elements were made at the five magnetic observatories, together with the necessary absolute observations and scale value determinations. Considerable progress was made in improving the instrumental equipment. At Cheltenham (Md.) field instruments have been standardized and variometers have been tested and adjusted. Working conditions at San Juan (P. R.) have been much improved by the erection of an office building and garage to replace those destroyed by the hurricane of 1928. At Tucson (Ariz.) atmospheric electric observations have been made continuously since September, 1929, with the cooperation of the Carnegie Institution of Washington and the United States Army Signal Corps. At Sitka (Alaska) special auroral observations have been continued. There has been cooperation with the Alaska Agricultural College and School of Mines at Fairbanks (Alaska), where a station for the observation of auroras has been established through a grant from the Rockefeller Foundation.

Seismology.—Seismographs were operated continuously at the Sitka and Tucson observatories, at Honolulu in cooperation with the University of Hawaii, and at Chicago in cooperation with the University of Chicago. Provision was made in the new office building at San Juan for the installation of two Wenner seismometers, and observations at this station, which were stopped by the 1928 hurricane, will be resumed early in the next fiscal year. At Sitka a Wood-Anderson seismometer has been in use temporarily, to find whether a Wenner seismograph could be operated without serious interference from microseisms. Cheltenham has been used merely as a station for experiment and test, because of the nearness of the well-equipped station at Georgetown University.

Arrangements for the systematic collection of reports of visible and felt effects of earthquakes have progressed very satisfactorily. The National Research Council, through its division of geology and geography, the Jesuit Seismological Association, and other organizations are cooperating efficiently in the eastern part of the country, and the collection of information for the Pacific coast region has been centralized at the San Francisco field station of this bureau. Considerable study has been given to two important earthquakes, the one of September 12, 1929, in western New York, and the one of November 18, 1929, on the Grand Banks, which did great damage to trans-Atlantic cables.

TIDE AND CURRENT WORK

The tide and current work during the past year comprised the operation of a number of primary tide stations for the purpose of furnishing general tidal control for the various regions; the operation of numerous secondary tide stations for use in connection with hydrographic surveys; the establishment of basic bench marks at several of the primary tide stations; the carrying on of special tide and current surveys in Long Island Sound and the Hudson River; and the securing of additional current observations at a number of localities where the information was needed.

Primary tide stations.—Throughout the fiscal year 22 primary tide stations were in operation, 13 on the Atlantic coast, 3 on the Gulf coast, 4 on the Pacific coast, and 2 in Alaska. In September, 1929, an additional primary tide station was installed at Eastport, Me. In the operation of these stations it has been aimed to secure not only observations that would furnish data for hydrographic control but in addition furnish also data for the determination of accurate datum planes, for reducing the results of short series of observations to mean values, for furnishing the necessary data for court cases, and for determining secular changes in relation of land to sea. Particular attention was paid to the standardization of instruments and to the maintenance of fixed zeros of tide staff.

Of the 22 primary tide stations, 5 were operated on a cooperative basis with other governmental organizations, so that no expense for observers was incurred at any of these 5 stations. Under the arrangements made, these stations are functioning in a very efficient

manner. In the following list, primary tide stations which are operated on a cooperative basis are marked by an asterisk (*).

Primary tide stations

Eastport, Me.
Portland, Me.
Portsmouth, N. H.*
Boston, Mass.
New York, N. Y.
Atlantic City, N. J.
Philadelphia, Pa.
Annapolis, Md.*
Baltimore, Md.
Hampton Roads, Va.*
Charleston, S. C.
Mayport, Fla.*
Jacksonville, Fla.*
Daytona Beach, Fla.
Key West, Fla.
Pensacola, Fla.
Galveston, Tex.
La Jolla, Calif.
San Francisco, Calif.
Astoria, Oreg.
Seattle, Wash.
Ketchikan, Alaska.
Seward, Alaska.

At the end of the fiscal year arrangements were being made to establish a new primary tide station at Newport, R. I., on a cooperative basis.

Secondary tide stations.—In addition to the primary tide stations listed above, records for practically the entire year have been received from gauges located at Prospect Harbor, Me.; Ocean City, N. J.; Fort Lauderdale, Fla.; Everglades, Fla.; San Diego, Calif.; Los Angeles, Calif.; Cordova, Alaska; Honolulu, and Hilo, Hawaii. During the year a gauge was installed at Santa Barbara, Calif. Excepting Ocean City and Santa Barbara, the above gauges are maintained through cooperative arrangements with other organizations. Short series of tide observations at 146 other tide stations have been taken in connection with hydrographic work.

Basic bench marks.—During the year basic bench marks were established at eight primary tide stations so that now such basic bench marks have been installed at the following primary tide stations:

Boston, Mass.
Atlantic City, N. J.
Baltimore, Md.
Norfolk, Va.
Charleston, S. C.
Key West, Fla.
Pensacola, Fla.
La Jolla, Calif.
San Francisco, Calif.
Seattle, Wash.

Arrangements are being made for the installation of basic bench marks during the coming year at New York City and at Daytona Beach, Fla.

Inspection of tide stations.—The following tide stations have been inspected during the fiscal year and levels run between tide staff and bench marks. The importance of frequent inspections in the operation of the primary tide stations is recognized and all opportunities afforded for such inspection by field parties at distant stations have been embraced.

Portsmouth, N. H.
Portland, Me.
Prospect Harbor, Me.
Boston, Mass.
New York, N. Y.
Atlantic City, N. J.
Philadelphia, Pa.
Ocean City, Md.
Annapolis, Md.
Charleston, S. C.
Hampton Roads, Va.
Pensacola, Fla.
Everglades, Fla.
Galveston, Tex.
San Diego, Calif.
La Jolla, Calif.
Honolulu, Hawaii.
Hilo, Hawaii.
Seattle, Wash.
Ketchikan, Alaska.

Current and tide surveys of harbors.—In continuing the program of tide and current surveys of important harbors, Long Island Sound and Hudson River were completed during the fiscal year, observations at 130 current stations and 30 tide stations being made. The results have been tabulated and reduced and the manuscripts for publication are nearing completion.

In the last month of the fiscal year 1930 a tide and current survey of Narragansett Bay was begun. This will be completed in the coming fiscal year.

Miscellaneous current observations.—In connection with the hydrographic work of the survey, observations at 14 current stations were made. These observations furnish data at places where no information was previously at hand.

Density and temperature observations.—At a number of our primary tide stations daily density and temperature observations are taken by the tide observer in connection with his other duties at the tide station. Density and temperature observations are also taken in connection with our special current and tide surveys of harbors.

Summary of tide and current records received.—The following is a summary of tide and current records received in the office during the year.

	Stations	Months		Stations	Months
Automatic tide-gauge records	135	525	Density and temperature records	20	190
Tide books	44	17	Current records	295	[1] 1,120
Miscellaneous tide records	6	72	Leveling records	129	

[1] Days.

Cooperation.—In carrying on the tide and current work there is continued encouragement given to cooperation with other organizations because of the mutual benefits to be derived. At a number of our tide stations this office provides the instruments and instructions for operating the same, while the cooperative agency provides a shelter for the equipment and also supplies an observer to give daily attention to the tide gauge. The cooperative stations are subject to the same inspection as stations maintained wholly by this survey. Copies of the records are available to both organizations and usually the original records are filed in the archives of this office. Another form of cooperation consists in the exchange of tide and current data which have been obtained independently by different organizations.

Cooperation with the Army engineers has been especially valuable to this survey because of the need of both organizations for tide and current data. During the past year a considerable amount of tide data for the Hudson River and Long Island Sound has been supplied by the district engineers in New York and Providence. Tide stations at Jacksonville and Mayport, Fla., are maintained cooperatively with the office of the district engineer at Jacksonville.

Valuable tide information is also received from time to time from the Navy Department and tide stations maintained cooperatively with that department are located at Portsmouth, N. H., Hampton Roads, Va., and San Diego, Calif. A primary tide station at An-

napolis, Md., is maintained in cooperation with the Naval Academy and in addition to serving as a primary tide station is also used for the purpose of instructing midshipmen in tidal work.

A tide station at Honolulu is maintained cooperatively with the surveyor of the Territory of Hawaii in charge, and one at Hilo, Hawaii, with the United States Geological Survey.

Other cooperative tide stations operated during the past year include 1 at Cordova, Alaska, by the chamber of commerce of that city; 1 at Los Angeles, Calif., by the harbor department; 1 at Prospect Harbor, Me., by Henry Southworth Shaw; 1 at Fort Lauderdale, Fla., by the authorities of that city; and 1 at Everglades, Fla., by the Florida Railroad & Navigation Corporation.

The accomplishments of the Washington office during the fiscal year, by divisions and sections, follow.

CHIEF CLERK

The principal duties of this division are the upkeep of the mechanical equipment of the Washington office of the bureau; the supervision of the expenditures for office expenses, including the purchase of supplies for the office and to some extent for the field; the care and custody of most of the original records of the field surveys, as well as the library of printed publications; the general supervision of all matters relating to the personnel work, including reports of leaves of absence; the custody and accounting for the receipts from the sale of charts, publications, etc.

In the library and archives 129 hydrographic and 116 topographic sheets, each representing new surveys made by the bureau, were received. Other additions were blue prints (mostly showing surveys made by Army engineers), 724; maps, 2,907; charts, 2,168; field, office, and observatory records, 4,601; photographs and negatives, 251; prints, 441; lantern slides, 133; and books, 583.

The total number of permanent and temporary employees in the office and field forces, which includes commissioned officers and all employees appointed through civil-service certification, is: Office force, 236; field force, 213; total, 449. These figures do not include the persons engaged as rodmen, chainmen, heliotropers, and others in the field parties, nor seamen on vessels.

The receipts from the sale of charts and nautical publications prepared by the bureau amounted to $80,093.75. The funds realized from the sale of old property, work done, and miscellaneous sources amounted to $1,890.49.

DIVISION OF HYDROGRAPHY AND TOPOGRAPHY

All plans for field work and instructions for surveys are prepared in this division. Plans and specifications for new vessels and surveying equipment as well as repairs are also prepared and the construction of new vessels and launches is supervised. The coast pilot section prepares manuscripts for new editions of the various Coast Pilots and gets out an annual supplement for each volume. This section also prepares answers to the many requests for information referred to the division.

The construction of the tender *Westdahl* was completed and the vessel is now employed in surveys of the Alaska coast, operating as

a tender to one of the larger vessels. Construction was continued on the motor vessel *Hydrographer* and the tender *Gilbert.*

The former yacht *Corsair* was taken over and put into service with practically no alteration except for the installation of surveying equipment. The vessel was renamed the *Oceanographer* and at the close of the fiscal year was actively engaged in the survey of Georges Bank. The training section is now quartered aboard the *Oceanographer* where the newly appointed officers are given practical and theoretical training to fit them as ships' officers.

Plans and instructions were prepared for a complete and accurate survey of Georges Bank. New equipment for radio acoustic sound ranging was designed and put in successful operation for this work. Extensive improvements were made in the echo-sounding instruments installed in the various vessels on both the Atlantic and Pacific coasts. Experiments were continued looking toward the development of a shallow-water echo-sounding apparatus.

Field examinations were made and new editions were brought out for two of the pilot volumes, and the manuscript for one of the Philippine Island Pilots was revised. Work was started on an office revision of the Alaska Coast Pilot, Part II.

Work was continued on the office reduction of the photographic topography along the east coast of Florida.

DIVISION OF GEODESY

The following important pieces of work were completed during the year or were in progress at the end of the fiscal year:

Computation and adjustment of the following pieces of triangulation.—

1. Southeast Alaska: Triangulation in the following areas: Mary Island to Port Simpson, Holkham Bay, Crawfish Inlet, Tlevak Strait, Stephens Passage, Chatham Strait-Salisbury Sound-Cape Ommaney-Cross Sound, Portlock Harbor, Warm Spring Bay, Red Bluff Bay, Tebenkof Bay, Port Lucy, Patterson Bay, Port Malmesbury, Port Walter, Table Bay, Port Conclusion, Port Armstrong, outside coasts of Baranof and Kruzof Islands, Davidson Inlet, Icy Strait, Meares Passage, Keete Inlet, Excursion Inlet, Cross Sound to Lituya Bay, Port Frederick, Stikine River, Revillagigedo Channel, Sumner Strait, Duncan Canal, and Behm Canal.

2. Readjustment of the first-order triangulation net east of the ninety-eighth meridian; preliminary work only.

3. Preliminary computation of the triangulation along the Mississippi River between Cairo, Ill., and New Orleans, La.

4. Reduction of the triangulation in Haro Strait, Wash., to the North American datum of 1927.

5. Reduction of the triangulation in Los Angeles County, Calif., to the North American datum of 1927.

Computation and adjustment of leveling.—

1. Computation of 727 miles of first-order leveling located in New Mexico, Colorado, Pennsylvania, and Indiana.

2. The adjustment of the combined level nets of Canada and of the United States, involving nearly 70,000 miles of leveling.

Computation of the following astronomical and gravity work.—

1. Azimuths: 35 stations in the United States.

2. Longitudes: 16 stations in the United States.

3. Latitudes: 4 stations in the United States.

4. Laplace azimuths: Computation of true geodetic azimuths at 15 Laplace stations.

5. Isostatic reductions: Computation of the reduction for topography and isostatic compensation at 18 gravity stations in the United States, in the Bahama Islands, and in the West Indies. Computation of the deflections of the vertical in the meridian and prime vertical at 7 stations in the United States and along the Atlantic coast.

6. Gravity computations: Computation of 20 gravity stations in the United States, in the Bahama Islands, and in the West Indies, and of various standardizations and experimental work at Washington, D. C.

Investigations were carried on during the year in the following subjects: Interior of the earth, earth tides, methods of reducing gravity observations, and variation of latitude.

The following publications were issued by the division of geodesy during the fiscal year:

Special Publication 156, Triangulation in Hawaii.
Special Publication 8, Formulas and Tables for the Computation of Geodetic Positions (seventh edition).
Special Publication 158, Bilby Steel Tower for Triangulation.
Special Publication 159, The Bowie Method of Triangulation Adjustment as Applied to the First-Order Net in the Western Part of the United States.
Special Publication 160, Triangulation in Colorado (1927 datum).
Special Publication 161, First-Order Leveling in Hawaii.
Special Publication 164, First-Order Triangulation in Southeast Alaska.
Special Publication 166, Geodetic Operations in the United States, January 1, 1927, to December 31, 1929.
Special Publication 169, First-Order Leveling in Alaska.

DIVISION OF CHARTS

During the year 272,000 charts were printed and 264,000 distributed (sold or issued for official use). These are the biggest figures since the peak years of and immediately following the war. Chart sales have increased 50 per cent in five years. Tide Table distribution increased 44 per cent; Current Tables, 45 per cent; Coast Pilots, 33 per cent; Inside Route Pilots, 22 per cent, in the same period. The bureau's airway map work does not go back five years, but the past year shows proportionately larger increase in distribution.

For the program of sectional airway maps the general limits and nomenclature of the International Millionth Map of the World have been adopted. The first map of this series will soon be published.

Accomplishments, 1930

Charts, new	17
New editions	129
New prints	371
Reprints, no change	80
Airway maps, new	11
Reprints	11

Weekly Notices to Mariners, in collaboration with the Bureau of Lighthouses.

Charts and publications distributed

Year	Charts	Coast Pilot	Inside Route Pilot	Strip airway maps
1920	311,699	15,261	2,085	----------
1921	290,188	8,728	2,656	----------
1922	215,509	6,235	2,261	----------
1923	197,426	6,610	1,787	----------
1924	221,543	5,917	1,788	----------
1925	230,535	5,733	1,727	----------
1926	232,286	6,328	2,648	----------
1927	246,836	7,859	1,994	----------
1928	241,880	7,019	1,849	----------
1929	249,499	6,288	1,756	----------
1930	282,034	7,656	2,208	[1] 12,004

[1] Previously distributed by Aeronautics Branch.

Analysis of chart distribution, number of copies, and percentage of totals

Year	Sold	Per cent	Official distribution	Per cent	Condemned	Per cent	Total
1905	42,719	41.8	52,591	51.6	6,713	6.6	102,023
1910	52,068	43.6	58,307	48.8	9,019	7.6	119,394
1915	57,060	44.6	62,327	48.8	8,416	6.6	127,803
1920	124,845	40.1	173,929	55.8	12,925	4.1	311,699
1925	102,011	44.2	111,552	48.4	16,972	7.4	230,535
1926	132,605	57.1	85,171	36.6	14,510	6.3	232,286
1927	119,593	48.5	111,383	45.1	15,860	6.4	246,836
1928	122,242	50.5	106,654	44.1	12,984	5.4	241,880
1929	135,170	54.2	103,391	41.4	10,938	4.4	249,499
1930	153,995	54.6	110,151	39.1	17,888	6.3	282,034

Program, 1931.—In addition to maintenance of existing charts and maps and the publication of Notices to Mariners, there are projected 11 new charts, 4 reconstructed charts, 7 new strip airway maps, and 5 sectional airway maps.

DIVISION OF TERRESTRIAL MAGNETISM AND SEISMOLOGY

Terrestrial magnetism.—Good progress has been made in the preparation for publication of the observatory results. The results for 1923 and 1924 are now published for Cheltenham and Honolulu. The manuscript for Sitka, covering the same period, is in the hands of the printer, and that for Tucson and Vieques is nearly ready for publication. The work to be done on the results for later years has been much reduced by the adoption of the improved method of reading hourly values.

The results of field observations in 1929 have been submitted for publication, thus keeping this part of the work up to date. The publication entitled "United States Magnetic Tables and Charts for 1925" has been issued and preparation of the similar publication for Alaska for 1930 is well advanced. A paper on The Magnetic Declination in the Philippine Islands, prepared in this office, was published at Manila.

The preparation of publications giving information regarding the magnetic declination for individual States or groups of States was delayed by lack of personnel, but one covering the States of Delaware, Maryland, Virginia, West Virginia, Kentucky, and Tennessee was issued and correction sheets were prepared for some of those published previously.

A third edition of Directions for Magnetic Measurements was issued. It is being used extensively by the Carnegie Institution of Washington and by observers in other countries.

Much study has been given to the further improvement of instruments and methods of observation, involving design and testing of instruments and parts and the preparation of specifications for installation, housing, and operation.

Some attention has been given to the broad problems of terrestrial magnetism and there has been full cooperation with national and international organizations engaged in the study of these problems. Members of the division have participated in the activities of various scientific organizations, both as officers and in the presentation of papers.

Seismology.—The form of the principal seismological report issued by the bureau has been changed so as to bring about a considerable saving in the work of preparation, without detracting from its value to those making use of the results. This has been done after consultation with other organizations making instrumental investigations so that methods may be uniform in so far as this is desirable.

Thirty determinations of the position of earthquakes and the transmission of this information west to Manila and east to Europe were made during the year.

Plans have been made to modernize equipment at all stations as rapidly as possible. A seismograph intermediate in sensitivity between existing instruments has been developed and built, to meet a need which has been felt for some time.

Cooperation and advice have been given to universities and other organizations contemplating the installation of seismographs.

Study has been made of the problem of securing information as to what happens in the central region of an earthquake, to meet the needs of the engineers called upon to design structures for places subject to earthquakes.

DIVISION OF TIDES AND CURRENTS

Growing hydrographic activities and an ever-increasing demand on the part of the public for tide and current information have increased from year to year the office work of the division of tides and currents. Comprehensive current and tide surveys were begun in 1922 and have been continued each year since that date. The reduction, correlation, and publication of all tide and current data for the areas covered by these surveys, together with the preparation of tidal bench-mark publications and the increasing scope and number of the annual tide and current tables, have greatly increased the volume of work. For years the need for additional office personnel to meet the increasing demands made upon the division has been apparent. This need has now become imperative, as the reduction and publication of valuable data are being delayed by the lack of a sufficient force.

Special Publication No. 162, Tides and Currents in Chesapeake Bay, the seventh of a series on currents and tides in the important waterways of the United States, was issued during the fiscal year. Work has progressed during the year on two additional publications of this series, one covering Long Island Sound and the other the Hudson River. The publications of the series which have been issued to date are listed below:

Currents and tides in harbors

No. 111. New York Harbor, 1925.
No. 115. San Francisco Harbor, 1925.
No. 123. Delaware Bay, 1926.
No. 127. Southeast Alaska, 1927.
No. 142. Boston Harbor, 1928.
No. 150. Portsmouth Harbor, 1929.
No. 162. Chesapeake Bay, 1930.

Special Publication No. 163, Tidal Bench Marks, State of Oregon, received from the printer during the fiscal year, is the eighth of a series containing descriptions and elevations of tidal bench marks along the coasts of the United States. The ninth publication of the

series, covering the State of Washington, was in process of preparation at the end of the fiscal year. The following publications of this series have been issued:

Tidal bench mark publications

No. 83. New York, 1922.
No. 119. District of Columbia, 1925.
No. 128. Rhode Island, 1926.
No. 136. Connecticut, 1927.
No. 141. California, 1928.
No. 148. New Jersey, 1929.
No. 155. Massachusetts, 1929.
No. 163. Oregon, 1930.

Special Publication No. 154, Instructions, Primary Tide Stations, which was prepared as a supplement to Special Publication No. 139, was received from the printer during the fiscal year. This publication contains instructions pertaining to the operation of a primary tide station and the preliminary reduction of the records.

The list of annual tide tables was augmented during the year by the addition of a tide table for San Francisco Bay which was first issued for the year 1930. The table of subordinate stations in the Tide Tables, United States and Foreign Ports, was completely revised for all foreign ports. The table of subordinate stations in the Current Tables, Pacific Coast, was revised to include additional data.

The following table, showing the issue of the tide tables for each fiscal year for the 10-year period 1921–1930, is indicative of the demand for the tables:

Fiscal year	United States and Foreign Ports Tide Tables	Atl ntic Coast Tide Tables	Pacific Coast Tide Tables	New York Harbor Tide Tables	Boston Harbor Tide Tables	San Francisco Bay Tide Tables	Total
1921	3,577	5,678	14,957				24,212
1922	3,067	5,704	14,902				23,673
1923	2,479	5,440	15,054				22,973
1924	2,509	7,097	15,234				24,840
1925	2,218	6,727	15,849				24,794
1926	2,730	6,707	15,347				24,784
1927	2,692	6,934	15,911				25,537
1928	2,377	7,225	16,990	1,992			28,584
1929	3,234	7,266	16,887	956	1,461		29,804
1930	2,605	8,457	16,889	1,134	1,470	5,024	35,579

The following table shows the number of copies of the current tables issued for the fiscal years 1923 to 1930, separate current tables having been issued in 1923 for the first time:

Fiscal year	Atlantic Coast Current Tables	Pacific Coast Current Tables	Total	Fiscal year	Atlantic Coast Current Tables	Pacific Coast Current Tables	Total
1923	2,029	1,780	3,815	1927	3,722	2,311	6,033
1924	3,124	2,002	5,126	1928	3,614	2,501	6,115
1925	2,452	2,474	4,926	1929	3,492	4,040	7,532
1926	3,014	1,763	4,777	1930	4,054	3,098	7,152

The United States and Foreign Ports Tide Tables for 1930 include daily predictions for 89 reference stations and tidal differences and constants for 3,803 subordinate stations. Three new

reference stations—Swatow, China; Southampton, England; and Cuxhaven, Germany—were included in the 1931 edition.

In accordance with a cooperative arrangement for the exchange of tidal predictions, daily predictions for the annual tide tables are now exchanged between the Coast and Geodetic Survey and the following organizations: British Admiralty, 20 stations; Canadian Hydrographic Office, 4 stations; Deutsche Seewarte, 6 stations; Service Hydrographique, France, 4 stations; geodetic branch, Survey of India, 5 stations.

During the fiscal year the second of the series of tidal current charts was prepared for publication.

DIVISION OF ACCOUNTS

The regular annual appropriation for the Coast and Geodetic Survey for the fiscal year 1930 amounted to $2,515,860, which amount was supplemented by transfers from other departments, special appropriations, etc., to the extent of $210,426.48, making a grand total of $2,726,286.48. The actual disbursements during the period of the fiscal year amounted to $2,677,281.31.

INSTRUMENT DIVISION

This division supplies all of the instrumental equipment and the major part of the general property used by the ships and shore parties in their field work. Its functions are varied in that it is required to design and develop such new instruments and equipment as are desired in order to maintain or increase the accuracy of the field surveys and to reduce the costs. In this work the bureau is recognized as a leader throughout the world and the inventive and development activities of this division are of the greatest importance to the bureau's well-being.

Because of the precision with which the bureau's surveys must be carried on, the instruments designed must embody correct scientific principles; and continuous care is exercised to keep in touch with all developments in the scientific and engineering world, to insure that any new development which might be applicable to the bureau's work will be made use of. This may be illustrated by the rapid increase in the use of radio and its allied mechanisms in the survey's work, which has resulted in the development of radio acoustic ranging for locating positions far offshore and in measuring the ocean's depth by electrosonic methods. A few years ago equipment of this sort was entirely foreign to the bureau's work.

The division also services and stores instruments and other equipment, has charge of recording transfers of material between parties and the Washington office, and also accounts for material at the bureau's headquarters.

These various functions were successfully carried on during the past year and a number of new and improved instruments were brought out, the more important being:

1. *Tide gauge.*—This instrument has been under constant development for several years, and a number of decided improvements were made during this past year; more notably, a clock assembly which

can be removed without the use of tools and a new magazine and take-up rolls for the record sheet.

2. *Registering sheave.*—A new registering sheave for sounding was designed with a more easily read counter, which will allow measurements to be made directly to 0.1 of a fathom, and the position of this counter is so arranged that it can be read much more easily than those used in the past.

3. *Telescope cross-wire material.*—An interesting development during the year was the invention of a method of producing very fine fibers of glass which may be used to replace the conventional spider-web material previously used. Spider threads are weak and are apt to change their length when moistened, with the result that they lose their straightness. Similar threads of glass are very strong, very black in the field of view, and are practically unaffected by temperature and moisture. They are also much easier to install in the telescope than the spider thread.

4. *Graduated circles for theodolites.*—Experiments were conducted with the plating with chromium of the silver used on the graduated circles for theodolites. The silver used must be very soft and is easily scratched and tarnished. The plating with the hard material, chromium, gives a surface which does not tarnish and which is not easily scratched in the ordinary course of handling. The chromium also has a very pleasing appearance under the instrument's microscope.

5. *Tide-gauge pulleys.*—Tide gauges are connected to the sea by means of a wire passing over pulleys and connected to a large float. Friction in the pulleys, or other resistance due to them, causes an error in the measurement of the rise and fall of the tide. A new type of pulley was designed which has a large wheel, is very free-running, and is equipped with a device to prevent the jumping of the wire from the pulley and is so designed that new wire may be easily installed.

Very truly yours,

R. S. PATTON, *Director.*

18038—30——17

BUREAU OF NAVIGATION

DEPARTMENT OF COMMERCE,
BUREAU OF NAVIGATION,
Washington, July 1, 1930.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: In response to your request I submit the following report upon the work of the bureau during the past fiscal year.

AMERICAN SHIPPING ON JUNE 30, 1930

On June 30, 1930, the merchant marine of the United States, including all kinds of documented craft, comprised 25,214 vessels of 16,067,725 gross tons, of which 2,105 seagoing vessels of 10,233,125 gross tons were of 1,000 tons or over, compared with 2,256 vessels of 10,724,030 gross tons on June 30, 1929. Following is an analysis of the ownership of seagoing tonnage compared with one year ago:

Ownership and date	Steel		Wood		Total	
Private ownership (500 gross tons and over):	*Number*	*Gross tons*	*Number*	*Gross tons*	*Number*	*Gross tons*
July 1, 1929	1,433	7,018,726	520	643,770	1,953	7,662,496
July 1, 1930	1,449	7,207,405	482	610,961	1,931	7,818,366
U. S. Shipping Board (1,000 gross tons and over):						
July 1, 1929	628	3,315,692			628	3,315,692
July 1, 1930	478	2,663,879			478	2,663,879
Total, 1929	2,061	10,334,418	520	643,770	2,581	10,978,188
Total, 1930	1,927	9,871,284	482	610,961	2,409	10,482,245

Of these totals 1,117 vessels of 5,008,653 gross tons were engaged in the foreign trade and 1,292 vessels of 5,473,591 gross tons in the coasting trade.

Since June 1, 1921, when our foreign trade reached its greatest volume, 10,699,596 gross tons, there has been a steady decline, until June 1, 1930, it amounted to only 5,319,552 gross tons, a falling off of 5,480,044 gross tons. The decrease in the foreign trade is due principally to the scrapping of large vessels which belonged to the Shipping Board and to changes from foreign to coasting trade because of greater opportunities in that service.

Since June 1, 1921, the coasting trade, exclusive of the trade on the Great Lakes, has increased 4,953,981 gross tons. During the same nine years the total seagoing tonnage has decreased 2,526,063 gross tons.

During the year 1,020 vessels of 254,296 gross tons were built and documented, and on July 1, 1930, there were building or under contract to build in our shipyards 291 vessels of 486,602 gross tons. The corresponding figures for 1929 were 808 vessels of 128,976 gross tons built and 218 vessels of 169,862 gross tons under contract to build.

The new tonnage includes 2 steel passenger steamers of 29,892 gross tons, 7 steel cargo steamers of 48,427 gross tons, 2 steel steam ferries of 6,654 gross tons, 2 steel passenger motor ships of 9,527 gross tons, 1 steel cargo motor ship of 1,605 gross tons, and 6 steel motor ship tankers of 39,981 gross tons, aggregating 136,086 gross tons.

On June 30, 1930, the laid-up seagoing tonnage of the United States aggregated 541 vessels of 2,096,179 gross tons, as against 569 vessels of 2,232,449 gross tons on June 30, 1929.

Details of the world's laid-up tonnage, classification of American vessels by size, service, and power, and of vessels launched and under construction may be found in Merchant Marine Statistics for 1930, a publication prepared by this office.

As pointed out by Lloyd's Register of Shipping, while the present shipbuilding of the United States is still materially below that of Great Britain and Ireland, the gap is almost 200,000 tons less than it was a year ago. At this time last year Great Britain and Ireland were building more than the United States and all other countries combined, the proportion being 51.2 per cent, but their share of the world production at present is but 45.5 per cent. In the same period the share of the United States in the total output has grown from 4.2 to 7.8 per cent and that of the other countries combined from 44.6 to 46.7 per cent.

NAVIGATION LAWS

COASTING TRADE

Since the early days of our Government the coasting trade of the United States has been reserved to our national vessels, as most maritime nations reserve that trade to their own vessels, respectively, and with a few minor exceptions, vessels for our coasting trade must be built in the United States. The only outstanding maritime nation which does not so restrict this trade is Great Britain. A glance at the globe will show the relative importance of the coasting trades of the United States and the United Kingdom.

The considerations governing our coasting trade differ naturally from those in the foreign trade. Nearly a century ago the principle of maritime reciprocity was adopted by the United States in its foreign trade, and recognition of that principle is now the basis of the laws which govern communication by sea between nations. International trade is a bargain in which no one nation can assume successfully to dictate all the terms.

The regulations of the coasting trade between our own ports involve entirely different considerations. That trade is wholly within national jurisdiction, and its regulation is solely a matter of domestic policy.

Our coasting trade is the most valuable in the world. The building of war and coasting trade vessels for years has been the backbone of the shipbuilding industry on the seaboard.

Congress has legislated several times to restrict this trade to American owned and built vessels. Foreign interests have attempted repeatedly to find loopholes in those laws by which they might share in these emoluments. At times they have met with some success.

For instance, section 2 of the act of February 17, 1898, the existing law, provides:

> No foreign vessel shall transport passengers between ports or places in the United States, either directly or by way of a foreign port, under a penalty of two hundred dollars for each passenger so transported and landed.

Because it does not involve transportation "between ports or places in the United States" foreign vessels are taking on passengers in ports of the United States for excursion purposes and returning to the port of embarkation. This clearly, is an invasion of our domestic trade, and because of differences of laws and conditions governing foreign vessels on the high seas this trade is increasing. The Supreme Court (182 U. S., pp. 392–397) stated:

> The use of the words "coasting trade" indicates very clearly that the words were intended to include the domestic trade of the United States * * *.

This is brought to your attention as it seems desirable that there should be placed before you a condition affecting our merchant marine which apparently can be remedied only by act of Congress.

INTERNATIONAL CONVENTION ON SAFETY OF LIFE AT SEA

The International Convention on Safety of Life at Sea, signed in London, May 31, 1929, by the United States and 17 foreign maritime nations, is now before the United States Senate for ratification. Pressure of legislation and consideration of other conventions prevented its consideration by the Senate Committee on Foreign Relations during the past session.

INTERNATIONAL CONVENTION ON LOAD LINES

The International Convention on Load Lines met in London from May 20 to July 5, 1930, when a comprehensive convention was signed by the United States and the following foreign maritime countries: Germany, Australia, Belgium, Canada, Chile, Cuba, Denmark, Free City of Danzig, Spain, Irish Free State, Finland, France, Great Britain and Northern Ireland, Greece, India, Iceland, Italy, Japan, Latvia, Mexico, Norway, New Zealand, Paraguay, Netherlands, Peru, Poland, Portugal, Sweden, and the Government of the Union of Socialist Soviet Republics.

This convention doubtless will be transmitted to the Senate at the next regular session for the advice and consent of that body to its ratification. To a considerable extent it is supplemental to the Convention of 1929 on Safety of Life at Sea. These conventions together are undoubtedly the most important and effective steps every taken by maritime nations to promote safety of life at sea, and it is trusted the Senate will consent to their ratification. A great work has been accomplished which can not but be of lasting benefit to mankind.

LOAD LINES

The act to establish load lines for American vessels approved March 2, 1929, becomes effective September 2, 1930. A load line division was organized which conducted a survey with a view to learning the commercial practices in the loading of different types of ships engaged

in various trades that experience has demonstrated may be followed with safety to life and property.

Based upon information gathered by this study, regulations have been prepared for the establishment of load lines for American vessels of 250 gross tons and over, engaged in foreign trade (the Great Lakes excepted). In the formulation of these regulations due regard was given to the economic requirements of vessels. Shipowners, shipbuilders, and naval architects cooperated most effectively in the preliminary work. The assistance of the United States Load Line Committee appointed by the Secretary of Commerce in 1928 was invaluable.

The conclusions of the International Load Line Convention signed in London on July 5, 1930, have been freely adopted where they are applicable to the American vessels subject to the act.

ADMEASUREMENT OF VESSELS

As stated in previous reports, the necessity for the establishment of a proper admeasurement service in this country in the interest of our merchant marine is becoming more and more apparent. This will involve a reorganization of the service under the Department of Commerce which is responsible for the administration of the admeasurement laws. The present system of utilizing customs officers selected, appointed, and paid by the Treasury Department has been demonstrated, after years of experiment, as impractical, wasteful, and inefficient.

By the creation of at least 10 admeasurement districts, each in charge of a fully qualified admeasuring expert, coordination between these districts and with the Washington office, and the employment of competent men for no other purpose than the admeasuring of vessels, undoubtedly will result in an improvement in the service and will work greatly to the credit of the department and the benefit of shipowners.

The work of the small admeasurement office now in this bureau has increased materially during the year not only in quantity but in the service it has been able to render to owners and shipbuilders. The importance in the construction of vessels of keeping always in mind the benefits which may be secured under our admeasurement laws is more fully realized, and our rulings and suggestions to this end are being more freely sought.

During the year there have been measured for first documents 1,562 vessels of 318,546 gross tons, of which 26 were estimated to be over 1,000 tons each, aggregating 91,229 tons. During the preceding year 1,387 vessels of 272,592 gross tons were thus admeasured, of which 11, of 66,143 tons, were over 1,000 tons each. During the coming year this work doubtless will increase because of contracts let for combined freight and passenger vessels under the provisions of the Jones-White Act.

During the year 384 vessels were readmeasured, resulting in a reduction of 8,961 gross tons.

Of the 44 customs districts, including our insular possessions, 27 were visited by the adjuster of admeasurements and the admeasuring officers instructed in the law and regulations and their application to unusual conditions.

In this service, under collectors of customs, there are about 140 men engaged the whole or a part of the time, at a total cost of $81,442.

The increase in the quantity, importance, and technical difficulty of this work undoubtedly will require ultimately the addition to our force of a naval architect experienced in ship construction, familiar with blue prints relating to such construction, and with the regulations and practices of foreign countries.

NEW INSPECTION VESSEL FOR THE GREAT LAKES

The bureau operates five inspection vessels covering the Atlantic and Gulf coasts of the United States in the enforcement of laws requiring life-saving equipment, affecting the crews of vessels, preventing overcrowding of passenger steamers, and the various requirements for protecting life and property at sea. Nearly 200,000 vessels, large and small, are covered by these inspection vessels.

On the Great Lakes, however, we have no such facilities for inspection work. In those waters there are 987 documented vessels of over 2,600,000 tons, while out of every port there are, in addition, small motor vessels, aggregating nearly 32,000 in number, carrying during the season millions of our people in commerce and for pleasure. Congress has made ample provision of law for their protection, and it is in the interest of safety to life and property that those laws be reasonably enforced.

We have considered it essential, therefore, that for this purpose another vessel should be added to our fleet.

ENFORCEMENT OF THE NAVIGATION LAWS

The work of general enforcement of the navigation laws has proceeded throughout the year along regularly established lines. The enforcement of the rules and regulations governing the movement of vessels in the St. Marys River and the patrol of the course during regattas and marine parades has been carried out by the Coast Guard in its usual efficient manner. The same service again has been active in inspecting small vessels for life-saving equipment and has brought to the attention of the bureau many violations of the navigation laws.

The bureau has found throughout the year the same cordial cooperation on the part of steamship owners and masters in the administration of the navigation laws that has heretofore prevailed. Yacht clubs, motor-boat organizations, and motor-boat publications have educated their members and readers in the requirements of the law. Among motor-boat owners, with rare exceptions, we have met with an appreciative reception of our efforts to render the navigation of their vessels safer and to protect them from the usually thoughtless action of reckless operators.

During the year there were reported 7,417 violations of the various laws we administer and on which the department acted in the remission or mitigation of the penalties incurred.

The following table shows the work done by the various branches of the Federal service engaged in the enforcement of the navigation laws in comparison with previous years:

Headquarters port	Total	Kilkenny	Tarragon	Dixie	Siwash	Psyche	Coast Guard	Steamboat Inspection Service	Customs Service	Navigation inspectors
Baltimore	746	709				4	1	17	15	
Boston	441				180		60	28	173	
Bridgeport	182				99		39		44	
Buffalo	43					28	6	8	1	
Charleston	68		14				16		38	
Chicago	49						14	10	23	2
Cleveland	172					24	21	16	39	72
Detroit	234						107	6	121	
Duluth	30						2		6	22
Galveston	32						25		7	
Honolulu	32								32	
Indianapolis	12							5		7
Juneau	58						3		55	
Los Angeles	336						56	26	195	59
Louisville	8							3	5	
Memphis	35								18	17
Milwaukee	26						2	13	11	
Mobile	76			31			2	6	37	
New Orleans	217			63			19	22	113	
New York	951				337	104	208	26	276	
Nogales	2								2	
Norfolk	448	276				49	58	19	46	
Ogdensburg	36					13			23	
Pembina	1								1	
Philadelphia	568	253				12	131	6	166	
Pittsburgh	23								23	
Port Arthur	24							8	16	
Portland, Me	264				159		17	7	79	2
Portland, Oreg	86							5	66	15
Providence	103				31		22	1	3	46
Rochester	75					3	33		4	35
St. Albans	41								41	
St. Louis	9								9	
San Antonio	16								16	
San Francisco	327						176	33	118	
San Juan	10								10	
Savannah	105	3	92						10	
Seattle	336						38		276	22
Tampa	977	10	106	159			97		605	
Wilmington	218					120	79	1	18	
Total—										
1930 (40 ports)	7,417	1,251	212	253	806	357	1,232	266	2,741	299
1929 (41 ports)	7,887	960	227	295	1,222	547	1,167	211	2,868	390
1928 (40 ports)	8,643	1,009	144	268	1,537	596	1,019	321	3,397	352
1927 (39 ports)	8,306	743	368	69	1,176	400	1,548	423	3,227	352
1926 (39 ports)	10,778	987	387	315	941	1,909	1,504	245	3,548	941
1925 (40 ports)	9,544	472	401	515	970	874	1,179	222	4,040	871
1924 (40 ports)	8,867	1,192	787	1,078	671	586	616	327	3,312	297
1923 (40 ports)	11,251	1,332	829	1,111	1,060	1,172	521	799	3,883	540
1922 (41 ports)	11,396	1,184	999	764	1,275	2,500	509	317	3,203	630
1921 (42 ports)	10,706	1,637	1,112	1,182	712	479	404	773	3,869	529
1920 (42 ports)	10,667	1,303	1,261	41			300	2,083	5,028	626
1919 (41 ports)	7,382	1,480	1,226				235	767	3,114	554
1918 (49 ports)	4,893	84	809				241	404	2,654	696
1917 (48 ports)	7,565		1,234	864			1,255	712	2,833	654
1916 (48 ports)	7,895		987	984			1,333	590	2,876	1,089
1915 (48 ports)	6,860		1,425				1,380	361	2,661	999

Of the 7,417 violations reported, 2,879 were discovered by the five patrol boats of the Navigation Service, these vessels operating along the Atlantic and Gulf coasts. The record of the work of these vessels is better shown by the fact that during the year they made 27,169 inspections. The number of violations found as compared with the number of inspections is a fair index of the extent to which the safety laws on small vessels are being complied with.

The following table shows the enforcement of such laws by customs districts and laws violated:

Table showing, by ports, the navigation laws violated and the number of violations during the year ended June 30, 1930

Headquarters port	Total	Steamboat laws (R. S. 4399–4500, U. S. C., Title 46, secs. 361–498)	Motor-boat laws (36 Stat. 462, U. S. C. 511–519) "Rules of road" (26 Stat. 320–328, 28 Stat. 645–650, 29 Stat. 690–691, U. S. C., Title 33, secs. 61–351)	Surrendered license (R. S. 4325–4326, U. S. C., Title 46, secs. 267–268)	Seamen's act (38 Stat. 1169, 1164, U. S. C., Title, 46, secs. 672–673	Anchorage and St. Marys River rules (29 Stat. 54, 34 Stat. 136, U. S. C., Title 33, sec. 474)	Passenger act (22 Stat. 186–191, U. S. C., Title 46, secs. 151–162, 171)	Enrollment and license (R. S. 4336, U. S. C., Title 46, sec. 277)	Entry and clearance (R. S. 4197, U. S. C., Title 46, sec. 91)	Name on vessel (R. S. 4178, U. S. C., Title 46, sec. 46)	Change of master (R. S. 4335, U. S. C., Title 46, sec. 276)	Unlading (R. S. 4351, 4355, U. S. C., Title 46, secs. 296, 300)	Numbering act (40 Stat. 602, U. S. C., Title 46, secs. 288–289)	Miscellaneous
Baltimore	746	62	546	12				2	1	10			104	9
Boston	441	43	207	49			2	13	13	20	2	1	75	16
Bridgeport	182	2	119	28	1			3		4			22	3
Buffalo	43	12	24					1		1			5	
Charleston	68		22	29						3	1		13	
Chicago	49	6	21	8	2	1		1					10	
Cleveland	172	8	106	18	4			1	5	2			26	2
Detroit	234	6	123	23				8	26	8			34	6
Duluth	30	2	23	2					3					
Galveston	32		19	5				2	1	2			1	2
Honolulu	32		6	2									15	9
Indianapolis	12	5	6										1	
Juneau	58	14		26				5	4	1			6	2
Los Angeles	336	44	68	53				11	16	6	2	1	37	98
Louisville	8		2	5									1	
Memphis	35		15	7				3					10	
Milwaukee	26	11	4	7				1	3					
Mobile	76	6	31	34					1				2	2
New Orleans	217	20	85	24	1			7	4	19	4		44	9
New York	951	43	517	226	1			19	9	28	13		92	3
Nogales	2													2
Norfolk	448	32	288	34	2			6		13	2		57	14
Ogdensburg	36		22	9					1				2	2
Pembina	1			1										
Philadelphia	568	7	304	86				12	4	31	1		119	4
Pittsburgh	23		1	15									7	
Port Arthur	24	9	4	6									4	1
Portland, Me	264	6	127	18	2			1	8	21			81	
Portland, Oreg	86		48	22					1		1		13	1
Providence	103	1	86	3				1		5	2		3	2

Rochester	75	2	66	4								3	
St. Albans	41		3						36			2	
St. Louis	9		4	4								1	
San Antonio	16		3	3								9	1
San Francisco	327	31	97	41	3		7	13	9	15	7	5	64	35
San Juan	10		2	1							3			4
Savannah	105		86	10						3			6	
Seattle	336	13	40	51	2		7	5	22	22	1	13	125	35
Tampa	977		321	85				17	182	11			359	2
Wilmington	218	4	147	13	1			10		4			37	2
Totals—														
1930 (40 ports)	7,417	389	3,593	964	19	1	16	142	349	229	39	20	1,390	266
1929 (41 ports)	7,887	375	3,873	1,078	13	5	16	177	345	198	37	34	1,335	401
1928 (40 ports)	8,643	534	3,537	1,070	21	3	12	295	821	145	34	21	1,869	281
1927 (39 ports)	8,306	654	3,244	1,130	21	2	2	283	464	197	77	22	1,983	227
1926 (39 ports)	10,778	2,501	3,722	1,330	47	3	9	178	272	285	83	18	2,080	248
1925 (40 ports)	9,544	922	3,487	1,446	34	4	5	453	238	224	92	16	2,374	249
1924 (40 ports)	8,867	547	2,782	1,069	104	55	18	185	116	445	78	16	3,201	250
1923 (40 ports)	11,251	695	3,069	945	405	11	10	1,130	79	505	49	17	4,117	215
1922 (41 ports)	11,412	422	4,614	944	75		27	59	71	443	56	110	4,426	158
1921 (42 ports)	10,707	840	3,772	974	250		48	45	100	673	68	42	3,676	208
1920 (41 ports)	10,667	2,650	2,530	988	514		16	38	104	267	39	118	3,192	160
1919 (40 ports)	8,173	1,589	2,397	1,066	273		28	38	83	196	32	83	2,244	86
1918 (49 ports)	4,749	710	2,337	922	160		32	20	62	127	27	250		82
1917 (48 ports)	7,569	1,020	4,660	770	286		29	42	43	400	41	74		182
1916 (48 ports)	7,825	812	5,126	943	271	1	19	59	28	331	35	67		90
1915 (48 ports)	6,868	671	4,462	982		11	10	104	41	348	67	93		42
1914 (49 ports)	6,720	768	4,838	631		8	25	41	26	153	59	90		45
1913 (107 ports)	3,506	333	2,783	23		23	8	24	10	83	26	1		152
1912 (105 ports)	3,634	165	3,119	96		12	17	38	39	81	12			55
1911 (92 ports)	2,268	182	1,811	23		17	45	10	16	43	30			91
1910 (74 ports)	1,070	252	488	17		13	61	13	16	68	12	2		128
1909 (64 ports)	1,134	151	710	33		3	21	14	7	59		4		132
1908 (73 ports)	852	245	385	12		6	21	23	18	30	7	2		103
1907 (66 ports)	684	209	92	88		18	62	9	23	52	27	5		99
1906 (77 ports)	670	194	130	114		13	27	10	6	49	5	9		113
1905 (63 ports)	524	142	53	99		13	21	26	7	20	11	28		104
1904 (66 ports)	706	184	93	101		49	16	29	12	24	19	(1)		179

[1] Included under "Miscellaneous" in 1904 report.

During the year there were reported 389 violations of the steamboat inspection laws, the great majority of which consisted of a shortage in licensed officers or members of the crew. Often because of illness or for similar reasons it becomes necessary for an officer temporarily to leave the ship at ports where substitutes are not readily available. It has been the experience of the bureau, however, that these vacancies are filled at the first opportunity and that shipowners and masters are diligent in complying with the requirements of the safety laws.

Following is a comparative statement of cases of violations of the navigation laws, 1916–1930:

Port	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930
Baltimore	312	461	265	500	663	699	482	480	419	161	300	361	551	517	746
Boston	412	427	194	243	626	607	898	711	566	767	800	833	513	534	441
Bridgeport	54	89	32	95	97	200	50	287	131	206	131	310	231	199	182
Buffalo	144	87	111	168	143	188	62	116	262	90	24	34	257	103	43
Charleston	39	50	28	109	40	44	68	192	136	105	82	110	82	57	68
Chicago	389	283	144	88	119	171	97	179	165	139	76	97	30	68	49
Cleveland	218	161	177	499	1,096	252	160	154	303	187	97	84	168	144	172
Des Moines	4	116	56	27	40	141	32	62	48	11			3		
Detroit	441	163	146	142	122	168	67	184	311	80	83	184	182	202	234
Duluth	79	138	132	282	241	73	68	245	79	44	42	38	33	46	30
Eagle Pass		1	1												
Galveston	50	105	54	21	24	41	8	10	167	78	57	26	31	14	32
Great Falls									3					1	
Honolulu	18	18	11	10	3	95	35	22	16	45	10	12	18	14	32
Indianapolis	109	54	85	32	34	29	37	3	2	4		7	4	8	12
Juneau	33	40	44	43	39	60	36	77	130	106	78	51	45	55	58
Laredo	7	10													
Los Angeles	172	137	109	192	125	183	185	178	131	127	171	261	281	405	336
Louisville	63	128	50	49	64	35	57	29	26	28	54	35	18	44	8
Memphis	94	84	18	67	83	66	86	62	162	150	154	120	49	81	35
Milwaukee	133	82	18	81	133	33	14	79	17	5	7	104	1	25	26
Mobile	106	109	52	98	122	301	203	334	234	191	96	263	42	186	76
New Orleans	177	315	221	501	487	779	294	467	790	371	411	186	285	226	217
New York	1,256	1,292	583	626	1,349	849	2,698	1,475	663	1,625	2,454	1,185	1,170	1,233	951
Nogales			22		8	21	13		7	12	10	14	3	9	2
Norfolk	531	430	181	814	618	846	680	682	412	375	842	434	345	354	448
Ogdensburg	92	74	201	54	18	8	85	85	18	112	58	142	50	87	36
Omaha						1							2	2	
Pembina			3											1	1
Philadelphia	483	406	166	532	600	684	778	624	360	854	549	303	493	466	568
Pittsburgh	27	4	6	9	28	16	22	14	41	35	16	53	39	43	23
Port Arthur	68	93	117	203	256	112	21	17	216	84	52	15	61	29	24
Portland, Me	241	145	51	53	55	320	346	440	295	393	684	159	645	337	264
Portland, Oreg	229	130	239	120	182	107	83	101	171	291	237	84	100	125	86
Providence	125	94	68	65	137	175	181	98	94	144	169	217	104	113	103
Rochester	42	44	102	14	24	55	10	61	57	53	18	24	130	34	75
St. Albans	33	68	29	1	1	3	96	2		4	4	22			41
St. Louis	154	348	173	291	396	182	173	179	127	89	100	64	57	46	9
St. Paul	5			4							1				
San Antonio [1]			2	2	7	9	10	25	23	28	15	8	9	34	16
San Diego [2]					1	22	34	32							
San Francisco	276	196	151	223	765	466	213	291	288	284	281	238	277	227	327
San Juan	11	12	14	8	14	10	14	19	18	26	25	22	23	25	10
Savannah	82	48	41	77	68	149	165	163	126	126	67	47	60	95	105
Seattle	409	318	338	266	320	310	272	1,223	294	564	755	328	360	290	336
Tampa	570	547	295	1,303	1,247	1,770	2,300	1,649	1,386	1,398	1,690	1,519	1,609	1,075	977
Wilmington, N.C.	137	262	19	261	302	426	263	200	173	152	78	312	282	333	218
Total (47 ports)	7,825	7,569	4,749	8,173	10,667	10,706	11,396	11,251	8,867	9,544	10,778	8,308	8,643	7,887	7,417

[1] The districts of Laredo (No. 23) and Eagle Pass (No. 25) were abolished by Executive order Sept. 7, 1917, and the district of San Antonio (No. 23) was created by the same order.

[2] The districts of Los Angeles and San Diego were consolidated by Executive order of Jan. 26, 1923, with Los Angeles as headquarters port.

PREVENTING OVERCROWDING OF PASSENGER VESSELS

One of the small but most important services we have is preventing excursion vessels exceeding the safety limit in carrying passengers. There is a constant temptation on the master to take on a few more,

as every additional passenger carried is net profit. This has necessitated the closest supervision. In the certificate of inspection issued to the vessel is stated the number of persons she may safely carry. Inspectors are placed at the gang planks with automatic counters. When the prescribed number has been reached, no additional passengers are permitted on board.

The following table shows the counts made by the navigation and customs services by ports:

Port	Navigation		Customs		Total	
	Counts	Passengers	Counts	Passengers	Counts	Passengers
Baltimore	1,657	562,164	6	3,554	1,663	565,718
Boston	47	39,306	423	287,638	470	326,944
Bridgeport			4	5,728	4	5,728
Chicago	2,180	434,788	57	41,314	2,237	476,102
Cleveland	460	403,660	67	46,016	527	449,676
Detroit	908	1,043,685	5	6,697	913	1,050,382
Duluth		19,247				19,247
Galveston			71	7,615	71	7,615
Indianapolis	20	17,720			20	17,720
Louisville	138	99,937			138	99,937
Memphis	5	2,287			5	2,287
New York			926	2,263,684	926	2,263,684
Norfolk	552	90,583	20	3,594	572	94,177
Philadelphia			154	125,212	154	125,212
Portland, Me	267	46,335			267	46,335
Rochester	10	5,072			10	5,072
Seattle	250	41,077	506	12,669	756	53,746
Total, 1930	6,494	2,805,861	2,239	2,803,721	8,733	5,609,582
Total, 1929	6,583	2,888,247	1,870	2,648,584	8,453	5,536,831

During the year it was necessary on 316 occasions for the inspectors to stop passengers going on board, the limit of safety having been reached. This involved 163,185 passengers. Had our inspectors not been present doubtless there would have been overcrowding and perhaps lives endangered.

The following table shows in detail the occasions when the limit of safety had been reached before all the passengers had embarked:

Shut-offs, by specified months

Port	July, 1929		August, 1929		September, 1929		June, 1930		Total	
	Counts	Passengers	Counts	Passengers	Counts	Passengers	Counts	Passengers	Counts	Passengers
Baltimore	1	1,300	4	5,200			2	1,899	7	8,399
Boston	2	3,300	1	1,650					3	4,950
Chicago	46	17,219	14	7,326	20	5,888	5	424	85	30,857
Cleveland	2	5,600	1	2,800					3	8,400
Detroit	20	55,597	4	10,024	1	3,008	6	18,539	31	87,168
New York							44	15,700	44	15,700
Norfolk	3	1,274	3	987					6	2,261
Philadelphia	1	1,005							1	1,005
Portland, Me	1	200					1	300	2	500
Seattle	3	228	131	3,717					134	3,945
Total, 1930	79	85,723	158	31,704	21	8,896	58	36,862	316	163,185
Total, 1929	77	79,174	34	52,123	1	1,650	65	36,928	177	169,875

SHIPPING COMMISSIONERS

During the year 650,673 seamen were shipped, reshipped, and discharged, as compared with 627,392 the year before. The average cost to the Government per man was 23 cents.

Collectors of customs acting at ports where shipping-commissioner offices have not been established shipped and discharged during the year 44,197 officers and men as compared with 47,562 during the previous year.

Of the 334,780 men shipped before shipping commissioners 173,072 were native American and 54,323 were naturalized Americans; 227,395 in all, or 67.9 per cent. This does not give an entirely accurate view of the nationality of crews of our vessels, as under existing law masters may sign on a portion of their crews in foreign ports before United States consuls for the round trip. These men do not appear before our shipping commissioners and are not included in the following table, which shows the aggregate work and salaries of the shipping-commissioner service for the past 12 years:

Year	Seamen shipped, reshipped, and discharged	Salaries	Average cost per man	Year	Seamen shipped, reshipped, and discharged	Salaries	Average cost per man
1919	485,796	$72,288	$0.15	1925	552,124	$123,726	$0.22
1920	628,980	89,949	.13	1926	534,493	123,183	.23
1921	650,840	99,646	.15	1927	561,061	122,398	.22
1922	541,952	92,318	.17	1928	547,732	123,961	.23
1923	538,755	94,476	.17	1929	627,392	139,454	.22
1924	555,633	94,476	.17	1930	650,673	147,873	.23

The work of the shipping commissioners is a beneficent service. The seaman is employed under unusual conditions on voyages away from his home port, out of the protection of the courts and away from his friends. Congress, therefore, has legislated in detail for the payment of seamen's wages, the food served, quarters furnished, and their care if sick or injured.

During the year there has been turned over to shipping commissioners $103,673.55 in unclaimed, deserters', and deceased seamen's wages. The commissioners are under heavy bond and are responsible for this money.

PASSENGER ACT OF 1882

The condition of the accommodations extended to steerage passengers in recent years is a very material improvement over that which existed when the passenger act of 1882 regulating such transportation was passed. Under that act Congress provided in detail for the space to be provided each passenger, its ventilation and cleanliness, hospital spaces, eating accommodations, the separation of the sexes, and general supervision of moral conditions, medical facilities and attendance, and in other ways so far as possible protected the health and welfare of its future citizens.

The following table shows the number of steerage passengers brought to our ports each year since 1925 on steam vessels inspected for this purpose and the number of voyages made by such vessels:

Year	Voyages	Steerage passengers	Year	Voyages	Steerage passengers
1925	1,257	187,127	1928	1,384	301,223
1926	1,334	215,639	1929	1,422	327,018
1927	1,367	275,175	1930	1,347	326,767

NAVIGATION RECEIPTS

Revenue collected by the bureau from all sources during the year aggregated $2,320,670.19. Attention again is invited to the fact that the amounts thus collected from our merchant marine exceeded by nearly $800,000 the entire expense of the Bureau of Navigation and the Steamboat Inspection Service combined.

These receipts in detail were as follows:

June 30—	Tonnage duties	Navigation fees	Navigation fines	Total
1930	$2,021,295.94	$236,781.02	$62,593.23	$2,320,670.19
1929	2,014,438.06	249,483.21	54,729.90	2,318,651.17
1917	1,393,743.16	159,808.03	49,962.37	1,603,513.56

PUBLICATIONS

Publications of the bureau comprise the Navigation Laws (quadrennial with annual pamphlet supplements), Merchant Vessels of the United States (annual), Code List of Seagoing Vessels (annual), and American Documented Seagoing Merchant Vessels of 500 Gross Tons and Over (monthly).

Appendixes and statistics of the merchant marine formerly printed as a part of the bureau's annual report are now published as a separate document known as Merchant Marine Statistics.

The above publications are no longer issued gratuitously, but are for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C.

In addition to the above, the bureau issues regulations governing the navigation of the St. Marys River, the establishment of load lines, the admeasurement of vessels, the navigation and equipping of small motor boats, the recording of mortgages and bills of sale, and regulations governing regattas and marine parades.

Very truly yours,

A. J. Tyrer,
Commissioner of Navigation.

STEAMBOAT INSPECTION SERVICE

DEPARTMENT OF COMMERCE,
STEAMBOAT INSPECTION SERVICE,
Washington, July 1, 1930.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: Herewith is submitted a report on the work of the Steamboat Inspection Service for the fiscal year ended June 30, 1930.

PERSONNEL

The following positions were embraced in the service at the end of June, 1930:

Central office:	
Supervising Inspector General	1
Deputy Supervising Inspector General	1
Administrative assistant to the Supervising Inspector General	1
Traveling inspectors	6
Clerks	12
Messenger	1
Total, central office	22
Field:	
Supervising inspectors	11
Local inspectors of hulls	47
Local inspectors of boilers	47
Assistant inspectors of hulls	74
Assistant inspectors of boilers	74
Clerks	93
Total, field	346
Grand total	368

EXPANSION OF FORCE

The last annual report of the Supervising Inspector General stressed the necessity for a material expansion of the Steamboat Inspection Service in order to meet the requirements of law and to make more thorough annual inspections and to permit of more frequent reinspections. In the appropriations for the year ending June 30, 1931, Congress made provision for 45 additional assistant inspectors and 16 additional clerks. As a result of this increase, it is now possible to make more frequent reinspections of a class of vessels not heretofore properly covered. Accordingly, under date of June 23, 1930, the following order was sent to all of the inspectors in this service:

> Commencing July 1, 1930, it is the desire of the bureau that three reinspections be made of each American and each foreign passenger vessel, whether under reciprocity or not, during the season of navigation or year for which certificated in addition to the annual inspection each year.

In carrying out this order it is expected that you will use good judgment, taking into consideration the conditions incident to the operation of the ship, the purpose being to see that all equipment is in good condition and ready for immediate use, stressing particularly the launching and handling of lifeboats and the exercising of the crew in pulling oars. Except in instances where all lifeboats are lowered, which would be an unusual condition, different lifeboats are to be used at each reinspection and notation made in Form 840–F.

That requirement, applying to foreign as well as American ships, places the responsibility upon the inspector when reinspecting to see that all equipment is in good condition and ready for immediate use, stressing particularly the launching and handling of lifeboats and the exercising of the crew in pulling oars. For many years three reinspections of excursion and ferry steamers have been required during a year or season of navigation. The order of June 23, 1930, extends the requirements to other vessels. The last two paragraphs of the section of Rule III of the General Rules and Regulations Prescribed by the Board of Supervising Inspectors, relating to the handling of boats and rafts, read as follows:

At least once in each interval of not longer than three months, the master of every inspected passenger vessel shall drill and exercise every member of the crew, except females, in pulling oars in the ship's lifeboats.

In addition, the crew of the motor-propelled boats shall demonstrate their ability in the working of the engine and handling of the boat under power.

The expansion of the force makes it practicable to extend the inspections to determine that these regulations are being enforced.

In the estimates for the fiscal year ending June 30, 1932, there is an item asking for an appropriation to pay for the salaries of six additional clerks in the office of the Supervising Inspector General. The efficiency of the service will depend largely upon providing the central office with a sufficient number of employees to follow up intelligently the system of reporting required of inspectors. Manifestly, in a service that is expanding such as this—as a result of the construction of new passenger ships for the American merchant marine—additional clerical help is needed to handle promptly the large increase in correspondence in the central office.

Under the law the Board of Supervising Inspectors is required to promulgate regulations relative to the inspection of vessels and the conduct of licensed officers. These rules and regulations are set forth in the publication entitled "General Rules and Regulations Prescribed by the Board of Supervising Inspectors." The last session of the Board of Supervising Inspectors commenced on January 15 and ended on February 20, 1930. During that period there were before the board 104 cases, on which 32 hearings were held. Several of the most important hearings were recorded verbatim, and it appears that the entire proceedings of the board should be made in this manner. Under present circumstances this is not possible, but should the request for additional clerical force in the central office be granted, the proper recording of minutes and the keeping of records could be effectively performed.

LESSONS FROM DISASTERS

Upon the Supervising Inspector General rests the responsibility of studying the causes of all major disasters and devising means whereby the danger of their repetition may be minimized. Accordingly he

has repeatedly gone into the districts to assist the inspectors in ascertaining the facts with reference to disasters.

Last fall there were three major disasters on Lake Michigan. The first was the loss of the steamer *Andaste*, of 1,439 gross tons, on September 9, 1929, while en route from Grand Haven, Mich., to Chicago, Ill., with a crew of 25 and a cargo of gravel. The second was the car ferry *Milwaukee*, of 2,933 gross tons, which left the port of Milwaukee at 3 p. m., October 22, 1929, bound for Grand Haven, Mich., and has never been heard from since. There were 47 lives lost. The third was the steamer *Wisconsin*, of 1,921 gross tons, which sank on October 29, 1929, 4 miles offshore from Kenosha, Wis., resulting in the loss of 9 of the crew.

The Supervising Inspector General went into each of those disasters carefully, and at the last meeting of the Board of Supervising Inspectors the following requirements were added to strengthen its regulations:

1. The submission of blue prints covering new construction and changes in construction to the Supervising Inspector General.
2. The carrying of a life raft on vessels on the Great Lakes in addition to their lifeboat equipment.
3. The carrying of additional distress lights in the pilot house or upon the navigator's bridge of Great Lakes vessels of 150 gross tons and over.

In connection with the loss of the *Andaste* and the *Milwaukee*, a study is being made of radio conditions on the Great Lakes, with a view to determining whether the use of radio should be extended. The supervising inspectors of the eighth and ninth districts are conducting a special investigation to assist in determining to what extent there should be a change in the construction of car ferries on the Great Lakes.

On June 10, 1930, a collision occurred between the passenger steamer *Fairfax* and the tanker *Pinthis* in the waters of Massachusetts Bay, resulting in the loss of the lives of 50 persons. The Supervising Inspector General proceeded to Boston and counseled with the local inspectors at that port, who investigated the disaster, with a view to determining what constructive suggestions could be made so as to reduce such disasters to a minimum. In a general report covering the matter, the Supervising Inspector General suggested—

1. I recommend that you call a conference of the shipowners for the purpose of working out a plan for establishing passing lanes in coastwise waters. The necessity for this has been established in Massachusetts Bay, but my thought is, while the conditions there may be met by establishing passing lanes, to also give attention to the same problem in other waters where it may be necessary.
2. The law is strict with reference to the transportation of dangerous articles on steamers carrying passengers. Gasoline as cargo would not be permitted to be transported on a steamer carrying passengers, but here we have a disaster where a vessel that is forbidden by law to carry gasoline as cargo is the victim by fire, and lives are lost, as the result of a collision with a vessel which is permitted by law to carry gasoline as cargo. While there is no violation of any legal rule in the transportation of gasoline as cargo in a ship not carrying passengers navigating crowded waters in a fog, there is, I submit, a question as to the moral right to do this thing, and I recommend that you call a conference of the owners and operators of tankers with a view to working out a plan by which there may be an understanding that these vessels shall anchor in time of fog in waters where there will be no danger of collision with passenger ships.

The conferences recommended have been agreed to, and they will be held some time in the early fall of the present calendar year. At that time the shipowners will collaborate with this service in working

out plans for securing greater safety, this service approaching the problem with the object in view to securing remedial measures through the cooperation of those at interest rather than through legislation.

INCLINING TESTS OF VESSELS

A recent appropriation permitted the employment of additional traveling inspectors for the purpose of more promptly conducting stability tests. Since that time four men have been constantly used on stability tests. The work of inclining ships is constantly increasing, due not alone to the construction of new vessels but also to the broadening of the regulations that require more attention be given to the actual seaworthiness of vessels, especially in hull construction, etc. If this work continues to increase as it has for the past two years it will be necessary next year to ask for additional personnel.

During the past fiscal year the inspectors have been busily engaged in inclining a number of vessels on the Lakes and in the vicinity of New York City. The work at New York City is almost completed, and considerable headway has been made in inclining a certain class of vessels on the Great Lakes. It is anticipated that this work will have been completed by the opening of the next season of navigation.

HARBOR LINE CHANGES

As a result of a study by the Board of Supervising Inspectors at its last annual meeting, a change has been made in the harbor lines of New York. The seaward limits of the harbor were changed from an imaginary line drawn from Navesink Lighthouse, 25½° true (NE.⅞ N. mag.), to the Life Saving Station on Rockaway Beach, to a line drawn from Sandy Hook Lighthouse, 30° true (NE. ¼ N.), to Rockaway Point, distant 6 miles.

REVISION OF BOILER RULES

In the last annual report reference was made to the revision of boiler rules, a subject so important that further comment appears necessary. The rules as revised tentatively have received very general commendation by those interests competent to judge. These rules which are now being reviewed by a special committee of eminent engineers will—when legislation is enacted authorizing the Board of Supervising Inspectors to prescribe rules—be not only equal to but surpass the marine-boiler rules of any nation in the world.

A detailed study is also being made of welding, electrical installation, and Diesel propulsion, and in due time the Board of Supervising Inspectors will be in a position to promulgate codes concerning these matters that will command the respect of all.

MOTOR-VESSEL INSPECTION

Last year the recommendation was again made that legislation should be enacted covering motor-boat inspection and officering. Operators should be properly examined by this service concerning their visual acuity, color sense, and knowledge of rules of the road. They should be 21 years of age and citizens of the United States. Neither of these qualifications is required at present. The inspec-

tion, of course, should be extended to make conditions safer upon vessels which are not now inspected, and the inspectors should be vested with authority concerning vessels of this type that are now subject to inspection.

EXPENDITURES

Following is a detailed account of the expenditures for the year ended June 30, 1930:

Salaries, office of the Supervising Inspector General, as well as for the field force	$1, 024, 943. 49
Traveling expenses (actual)	94, 308. 00
Rents, offices	31, 836. 37
Furniture, instruments, stationery, supplies, and transportation of same	15, 688. 38
Telephone rents and telegrams	7, 031. 13
Witness fees and mileage in cases of investigation	217. 30
Ice, fuel, and electric light	455. 70
Toilet service, laundry, soap, etc	267. 56
Janitor service	240. 00
Notarial certifications	537. 21
Repairs	302. 62
Miscellaneous	1, 106. 89
Total traveling and miscellaneous expenses	151, 991. 16
Salaries, 1930	1, 024, 943. 49
Salaries, 1929	1, 018, 959. 34
Increase, 1930	5, 984. 15
Contingent expenses, 1930	151, 991. 16
Contingent expenses, 1929	137, 954. 60
Increase, 1930	14, 036. 56
Rents, 1930	31, 836. 37
Rents, 1929	36, 069. 60
Decrease, 1930	4, 233. 23
Traveling expenses, 1930	94, 308. 00
Traveling expenses, 1929	85, 800. 37
Increase, 1930	8, 507. 63
Total traveling and miscellaneous expenses as noted above	151, 991. 16
Total salaries as noted above	1, 024, 943. 49
Total expenditures for year ended June 30, 1930	1, 176, 934. 65
Total expenditures for year ended June 30, 1929	1, 156, 913. 94
Increase, 1930	20, 020. 71

The above increases are due to increase in force.

NUMBER, CLASS, AND TONNAGE OF VESSELS INSPECTED

There is submitted herewith a tabulated statement showing the number, class, and tonnage of vessels regularly inspected by this service and granted certificates:

CERTIFICATES OF INSPECTION ISSUED BY DISTRICTS

Supervising district	Local district	Domestic vessels										Foreign passenger steam and motor vessels		Total	
		Steam vessels		Motor vessels		Passenger barges		Seagoing barges		Total					
		Number	Gross tonnage	Number	Gross tonnage	Number	Gross tonnage	Number	Gross tonnage	Number	Gross tonnage	Number	Gross tonnage	Number	Gross tonnage
First	San Francisco, Calif.	365	1,118,999	97	73,641			4	6,235	466	1,198,875	29	203,068	495	1,401,943
	Honolulu, Hawaii	14	37,473	4	3,083			2	910	20	41,466	20	281,121	40	322,587
	Los Angeles, Calif.	92	452,436	24	51,287			2	918	118	504,641			118	504,641
	Portland, Oreg.	63	103,033	14	988	2	1,076			79	105,097	1	10,220	80	115,317
Second	New York, N. Y.	1,403	2,666,863	140	165,151	2	1,822	114	126,123	1,659	2,959,959	174	2,727,203	1,833	5,687,162
	Albany, N. Y.	98	32,802	8	1,687					106	34,489			106	34,489
	New Haven, Conn.	35	9,240	24	1,102			1	2,216	60	12,558			60	12,558
	Philadelphia, Pa.	250	564,153	54	88,079			48	35,031	352	687,263			352	687,263
Third	Norfolk, Va.	170	241,407	139	28,478	2	620	76	88,481	387	358,986			387	358,986
	Baltimore, Md.	263	652,492	125	65,745			7	5,266	395	723,503			395	723,503
	Charleston, S. C.	21	10,745	36	1,519			3	4,379	60	16,643			60	16,643
	Jacksonville, Fla.	21	46,783	56	3,487			10	7,675	87	57,945	1	592	88	58,537
	Savannah, Ga.	33	86,522	4	262			3	5,141	40	91,925			40	91,925
Fourth	St. Louis, Mo.	60	13,286	20	697					80	13,983			80	13,983
	Dubuque, Iowa	22	4,043	36	1,045					58	5,088	1	18	59	5,106
Fifth	Boston, Mass.	178	482,569	9	3,465			26	27,206	213	513,240	8	29,420	221	542,660
	Bangor, Me.	5	399	28	974			7	9,325	40	10,698	3	1,947	43	12,645
	New London, Conn.	43	23,542	15	1,908			2	2,573	60	28,023			60	28,023
	Portland, Me.	39	23,646	15	595			10	6,440	64	30,681			64	30,681
	Providence, R. I.	50	89,961	9	4,531			8	13,590	67	108,082			67	108,082
Sixth	Louisville, Ky.	22	4,716	10	1,037					32	5,753			32	5,753
	Evansville, Ind.	30	9,094	9	541	1	139			40	9,774			40	9,774
	Memphis, Tenn.	45	9,746	8	347					53	10,093			53	10,093
	Nashville, Tenn.	46	7,719	7	363					53	8,082			53	8,082
Seventh	Pittsburgh, Pa.	71	17,848	12	277	1	263			84	18,388			84	18,388
	Cincinnati, Ohio	23	6,787	4	145					27	6,932			27	6,932
	Point Pleasant, W. Va.	24	3,243	6	133	1	109			31	3,485			31	3,485
Eighth	Detroit, Mich.	104	256,010	7	18,399					111	274,409	2	2,622	113	277,031
	Chicago, Ill.	112	409,185	9	12,693					121	421,878			121	421,878
	Duluth, Minn.	66	239,696							66	239,696	1	1,307	67	241,003
	Grand Haven, Mich.	31	32,600	5	215					36	32,815			36	32,815
	Marquette, Mich.	31	15,860	3	169					34	16,029	2	1,111	36	17,140
	Milwaukee, Wis.	76	196,803	12	1,460					88	198,263			88	198,263
	Port Huron, Mich.	32	22,598	4	894					36	23,492	3	15,500	39	38,992

Vessels inspected and certificates of inspection issued to steam and motor vessels and to barges during the year ended June 30, 1930—Con.

CERTIFICATES OF INSPECTION ISSUED BY DISTRICTS—Continued

Supervising district	Local district	Domestic vessels										Foreign passenger steam and motor vessels		Total	
		Steam vessels		Motor vessels		Passenger barges		Seagoing barges		Total					
		Number	Gross tonnage	Number	Gross tonnage	Number	Gross tonnage	Number	Gross tonnage	Number	Gross-tonnage	Number	Gross tonnage	Number	Gross tonnage
Ninth	Cleveland, Ohio	121	470,453	1	27					122	470,480			122	470,480
	Buffalo, N. Y.	191	555,692			2	233			193	555,925	8	20,264	201	576,189
	Oswego, N. Y.	19	6,794	12	5,471					31	12,265	7	2,282	38	14,547
	Toledo, Ohio	80	246,791	5	454					85	247,245	2	922	87	248,167
Tenth	New Orleans, La	244	617,592	39	2,723	5	5,117	2	3,476	290	628,908	24	117,888	314	746,796
	Galveston, Tex	135	480,980	14	32,709	1	945	24	28,009	174	542,643	1	8,049	175	550,692
	Mobile, Ala	109	378,243	22	782			13	15,830	144	394,855			144	394,855
	San Juan, P. R	7	16,301	6	119					13	16,420	10	36,459	23	52,879
	Tampa, Fla	18	26,116	10	834			3	1,026	31	27,976			31	27,976
Eleventh	Seattle, Wash	168	370,165	61	20,384	2	645	1	979	232	392,173	32	231,019	264	623,192
	Hoquiam, Wash	13	11,935							13	11,935			13	11,935
	Juneau, Alaska	11	747	18	1,478			1	1,809	30	4,034			30	4,034
	St. Michael, Alaska	8	1,728	11	534					19	2,262	5	5,011	24	7,273
	Total, 1930	5,062	11,075,836	1,152	599,912	19	10,969	367	392,638	6,600	12,079,355	334	3,696,023	6,934	15,775,378
	Total, 1929	5,282	11,421,902	1,087	521,569	18	10,145	379	400,015	6,766	12,353,631	320	3,355,193	7,086	15,708,824
	Increase (+) or decrease (−)	−220	−346,066	+65	+78,343	+1	+824	−12	−7,377	−166	−274,276	+14	+340,830	−152	−66,554

VESSELS INSPECTED, BY GEOGRAPHIC DIVISIONS

Geographic divisions														
Pacific coast	734	2,096,516	229	151,395	4	1,721	10	10,851	977	2,260,483	87	730,439	1,064	2,990,922
Atlantic coast	2,616	4,947,425	668	367,102	4	2,442	315	333,446	3,603	5,650,415	196	2,795,621	3,799	8,446,036
Western rivers	343	76,482	112	4,585	3	511			458	81,578	1	18	459	81,596
Great Lakes	863	2,452,482	58	39,782	2	233			923	2,492,497	25	44,008	948	2,536,505
Gulf coast	506	1,502,931	85	37,048	6	6,062	42	48,341	639	1,594,382	25	125,937	664	1,720,319
Total, 1930	5,062	11,075,836	1,152	599,912	19	10,969	367	392,638	6,600	12,079,355	334	3,696,023	6,934	15,775,378
Total, 1929	5,282	11,421,902	1,087	521,569	18	10,145	379	400,015	6,766	12,353,631	320	3,355,193	7,086	15,708,824
Increase (+) or decrease (−)	−220	−346,066	+65	+78,343	+1	+824	−12	−7,377	−166	−274,276	+14	+340,830	−152	−66,554

MISCELLANEOUS INSPECTIONS

Statement of steam vessels granted letters of approval of designs of boilers, engines, and other operating machinery inspected under an act of Congress approved June 9, 1910, which vessels are not inspected annually, only one inspection being made for letter of approval; hulls of United States Government vessels inspected; and boilers in or for United States Government steamers and buildings, and for other United States governmental purposes, inspected by inspectors of the Steamboat Inspection Service during the year ended June 30, 1930:

Local inspection district (port)	Steam vessels granted letters of approval		Government vessels inspected	Government boilers inspected	Local inspection district (port)	Steam vessels granted letters of approval		Government vessels inspected	Government boilers inspected
	Number	Gross tonnage				Number	Gross tonnage		
San Francisco, Calif.				67	Point Pleasant, W. Va.	1	48		29
Honolulu, Hawaii				32	Detroit, Mich.				16
Los Angeles, Calif.			2	32	Chicago, Ill.			1	65
Portland, Oreg.				61	Duluth, Minn.	1	27	3	7
New York, N. Y.	1	34	16	140	Grand Haven, Mich	1	24	1	12
Albany, N. Y.				16	Marquette, Mich.			1	12
New Haven, Conn.	2	48		13	Milwaukee, Wis.	1	54	4	35
Philadelphia, Pa.				63	Port Huron, Mich.	1	15		
Norfolk, Va.			1	89	Cleveland, Ohio			2	3
Baltimore, Md.				104	Buffalo, N. Y.			4	5
Charleston, S. C.			3	46	Oswego, N. Y.				9
Jacksonville, Fla.				16	Toledo, Ohio				8
Savannah, Ga.				57	New Orleans, La.			32	254
St. Louis, Mo.			5	185	Galveston, Tex.				79
Dubuque, Iowa			19	135	Mobile, Ala.				86
Boston, Mass.				48	San Juan, P. R.				3
New London, Conn.				10	Tampa, Fla.				6
Portland, Me.				7	Seattle, Wash.	2	175		49
Providence, R. I.				3	Hoquiam, Wash.			1	
Louisville, Ky.				52					
Evansville, Ind.				15	Total, 1930	14	1,179	96	2,203
Memphis, Tenn.				158	Total, 1929	10	495	67	2,063
Nashville, Tenn.			1	57					
Pittsburgh, Pa.	4	754		50	Increase	4	684	29	140
Cincinnati, Ohio				69					

REINSPECTIONS

A statement of vessel reinspections made by boards of local inspectors during the year ended June 30, 1930:

Local inspection district (port)	Steam vessels	Motor vessels	Barges, etc.	Total	Local inspection district (port)	Steam vessels	Motor vessels	Barges, etc.	Total
San Francisco, Calif.	113	45		158	Point Pleasant, W.Va.	19			19
Los Angeles, Calif.	5	2		7	Detroit, Mich.	95	12		107
Portland, Oreg.	14	1		15	Chicago, Ill.	24	4		28
New York, N. Y.	719	38	6	763	Duluth, Minn.	15			15
Albany, N. Y.	72	20		92	Grand Haven, Mich.	81	4		85
New Haven, Conn.	23	49		72	Marquette, Mich.	17			17
Philadelphia, Pa.	207	17		224	Milwaukee, Wis.	26	10		36
Norfolk, Va.	61			61	Port Huron, Mich.	19	2		21
Baltimore, Md.	40			40	Cleveland, Ohio	12			12
Charleston, S. C.	2			2	Buffalo, N. Y.	27		2	29
Jacksonville, Fla.	10	31		41	Oswego, N. Y.	10	19		29
Savannah, Ga.	21	8		29	Toledo, Ohio	12	11		23
St. Louis, Mo.	22			22	New Orleans, La.	78	9	5	92
Dubuque, Iowa	7			7	Galveston, Tex.	8	11	1	20
Boston, Mass.	87			87	Mobile, Ala.	13	7		20
Bangor, Me.	17	6	2	25	San Juan, P. R.	9	6		15
New London, Conn.	17	15		32	Tampa, Fla.	9	6		15
Portland, Me.	23			23	Seattle, Wash.	41	17		58
Providence, R. I.	46	4		50	Hoquiam, Wash.	2			2
Louisville, Ky.	12			12					
Evansville, Ind.	12			12	Total, 1930	2,104	357	16	2,477
Memphis, Tenn.	9			9	Total, 1929	2,173	333	27	2,533
Nashville, Tenn.	7	3		10					
Pittsburgh, Pa.	13			13	Increase (+) or decrease (−)	−69	+24	−11	−56
Cincinnati, Ohio	28			28					

CARGO VESSELS EXAMINED TO CARRY PERSONS IN ADDITION TO CREW

During the year ended June 30, 1930, 1,492 cargo vessels were examined to carry persons in addition to crew, under the provisions of the act of Congress approved June 5, 1920.

MARINE-BOILER PLATES TESTED

Following is a statement of marine-boiler plates tested at the mills during the year ended June 30, 1930, under the act of Congress approved January 22, 1894:

Inspected by assistant inspectors at	Plates rejected because of—										Total		
	Tensile strength	Surface defect	Light gage	Heavy gage	Lost	Spoiled at shears	Bending test	Lamination	Elongation	Wrong dimension	Rejected	Accepted	Inspected
Coatesville, Pa.	36	26	11	----	2	1	----	----	3	----	79	2,083	2,162
Philadelphia, Pa.	2	2	----	----	----	----	----	----	----	----	4	189	193
Pittsburgh, Pa.	----	----	2	1	----	----	----	3	----	----	6	339	345
Chicago, Ill.	5	----	----	----	----	----	8	----	----	----	13	264	277
Cleveland, Ohio	----	1	----	----	----	1	----	----	----	----	2	227	229
Total, 1930	43	29	13	1	2	2	8	3	3	----	104	3,102	3,206
Total, 1929	40	43	1	----	2	1	----	6	----	1	94	2,249	2,343
Increase (+) or decrease (−)	+3	−14	+12	+1	----	+1	+8	−3	+3	−1	+10	+853	+863

STEEL BARS TO BE USED AS STAYS AND BRACES TESTED

Following is a statement of steel bars to be used as boiler stays and braces tested during the year ended June 30, 1930:

Tested by assistant inspectors at—	Samples tested	Samples rejected	Bars accepted	Bars rejected
Coatesville, Pa.	82	----	292	----
Pittsburgh, Pa.	186	4	1,517	16
Chicago, Ill.	64	----	576	----
Buffalo, N. Y.	4	----	48	----
Total, 1930	336	4	2,433	16

NEW LIFE PRESERVERS INSPECTED

During the year ended June 30, 1930, new life preservers were inspected as follows:

Kind	Inspected	Passed	Rejected
Block cork	201,826	200,494	1,332
Balsa block	6,469	6,418	51
Kapok	309	309	----
Total, 1930	208,604	207,221	1,383
Total, 1929	176,117	174,447	1,670
Increase (+) or decrease (−)	+32,487	+32,774	−287

INSPECTIONS AT FACTORIES

During the year ended June 30, 1930, new apparatus at factories were inspected as follows:

Kind	Inspected	Passed	Rejected
New cork-ring life buoys	9,420	9,397	23
New balsa wood life buoys	355	355	
New life floats, balsa wood	10	10	
New lifeboats	552	552	
New life rafts	236	236	
New boat davits	346	346	

OFFICERS LICENSED

Officers licensed of all grades, by local districts, during the year ended June 30, 1930

Local district	Steam and motor vessels					Steam vessels		Motor vessels		Sail vessels of over 700 gross tons		Masters of barges of over 100 gross tons	Total
	Masters	Mates		First-class pilots	Second-class and special pilots	Chief engineers	Assistant and special engineers	Engineers	Operators	Masters	Chief mates		
		Ocean	Inland										
San Francisco, Calif.	397	270	48	11	1	404	334	176	487	62	5		2,195
Honolulu, Hawaii	22	22				13	18	6	40	2			123
Los Angeles, Calif.	132	85		1	9	102	102	66	366	15	1		879
Portland, Oreg.	72	22	17		2	75	65	43	215	8			519
New York, N. Y.	1,099	551	61	121	5	1,362	869	424	908	64	2	2	5,468
Albany, N. Y.	51		10	31	12	91	13	22	19				249
New Haven, Conn.	28	5	3	12	3	24	8	10	127	2			222
Philadelphia, Pa.	150	135	10	25	9	209	174	84	605	9			1,410
Norfolk, Va.	130	26	1	25	10	124	58	39	475	5			893
Baltimore, Md.	185	101	9	26	22	173	132	84	383	10			1,125
Charleston, S. C.	25	10	2	11	5	25	18	10	110	3			219
Jacksonville, Fla.	59	40		12	2	43	57	43	434	11			701
Savannah, Ga.	20	12	3	5		31	24	2	38			1	136
St. Louis, Mo.	25	2	10	23		55	17	14	233				379
Dubuque, Iowa	10		4	9		16	9	5	89				142
Boston, Mass.	190	183	5	14	4	175	161	42	273	22	1		1,070
Bangor, Me.	41	29	2	2	5	25	14	16	93	15			242
New London, Conn.	33	10	8	5		35	12	19	174	2			298
Portland, Me.	50	58	3	3	3	45	15	14	117	10			318
Providence, R. I.	34	21	2	6	4	48	23	14	99	6			257
Louisville, Ky.	19		5	8		16	4	10	52				114
Evansville, Ind.	6		3	7		10	3	7	72				108
Memphis, Tenn.	15		10	7		33		2	98				165
Nashville, Tenn.	10		7	9		26	5	7	61				125
Pittsburgh, Pa.	34		13	10	1	28	21	3	79				189
Cincinnati, Ohio	14		10	7		10	6	1	37				85
Point Pleasant, W. Va.	4		8	7	4	10	4	4	61			1	103
Detroit, Mich.	72	7	1	28	1	105	48	13	90				365
Chicago, Ill.	33	10		16	12	66	49	13	131				330
Duluth, Minn.	21	2		17	3	14	11	4	35				107
Grand Haven, Mich.	16			9	4	33	19	1	72				154
Marquette, Mich.	10	1		9	8	11	8		71				118
Milwaukee, Wis.	57	2		62	2	70	51	24	67				335
Port Huron, Mich.	63	1		24	2	49	48	1	24				212

Cleveland, Ohio	58	7	1	62		113	71	11	93				416
Buffalo, N. Y	67	3	2	29	10	103	48	12	64				338
Oswego, N. Y	15			4	2	26	15	2	153				217
Toledo, Ohio	13	1		11	1	30	22	3	77				158
New Orleans, La	208	148	15	34	33	274	200	79	165	15			1,171
Galveston, Tex	115	67		7	18	84	72	34	206	8			611
Mobile, Ala	63	41	4	17	5	68	28	21	143	8			398
San Juan, P. R	19	4				5	3	7	71	3			112
Tampa, Fla	24	12		3	2	26	31	32	203	3			336
Seattle, Wash	150	92	25	3	5	115	102	81	257	15	1		846
Hoquiam, Wash	26	10	5		2	10	4	4	10	3			74
Juneau, Alaska	14	10	2	1	4	7	13	17	128				196
St. Michael, Alaska	3	2	1		1	4	2	5	66				84
Total, 1930	3,902	2,002	310	733	216	4,421	3,011	1,531	7,871	301	10	4	24,312
Total, 1929	3,827	1,795	399	767	260	4,553	2,928	1,319	6,423	275	14	7	22,567
Increase (+) or decrease (−)	+75	+207	−89	−34	−44	−132	+83	+212	+1,448	+26	−4	−3	+1,745

CERTIFICATES OF SERVICE ISSUED TO ABLE SEAMEN

There is submitted herewith a tabulated statement showing the number of applications received for certificates of service as able seamen, the number of applications rejected, and the number of certificates issued during the year ended June 30, 1930:

Local inspection district	Applications received	Applications rejected	Certificates issued	Local inspection district	Applications received	Applications rejected	Certificates issued
San Francisco, Calif.	862	112	750	Marquette, Mich.	17	2	15
Honolulu, Hawaii	129	3	126	Milwaukee, Wis.	138	8	130
Los Angeles, Calif.	206	10	196	Port Huron, Mich.	27	10	17
Portland, Oreg.	88	27	61	Cleveland, Ohio	342	57	285
New York, N. Y.	2,382	152	2,230	Buffalo, N. Y.	206	22	184
New Haven, Conn.	8		8	Oswego, N. Y.	2		2
Philadelphia, Pa.	423	40	383	Toledo, Ohio	97	5	92
Norfolk, Va.	215	50	165	New Orleans, La.	562	28	534
Baltimore, Md.	831	136	695	Galveston, Tex.	150	3	147
Charleston, S. C.	37	5	32	Mobile, Ala.	224	20	204
Jacksonville, Fla.	203	25	178	San Juan, P. R.	14	2	12
Savannah, Ga.	97	12	85	Tampa, Fla.	72	1	71
Boston, Mass.	269	30	239	Seattle, Wash.	313	9	304
Bangor, Me.	29		29	Hoquiam, Wash.	20	1	19
New London, Conn.	20		20	Juneau, Alaska	11		11
Portland, Me.	70	2	68	St. Michael, Alaska	1		1
Providence, R. I.	121	18	103				
Detroit, Mich.	302	93	209	Total, 1930	8,851	902	7,949
Chicago, Ill.	235	11	224	Total, 1929	8,211	579	7,632
Duluth, Minn.	91	2	89				
Grand Haven, Mich.	37	6	31	Increase	640	323	317

CERTIFICATES OF EFFICIENCY ISSUED TO LIFEBOAT MEN

The following statement shows the number of applications received for certificates of efficiency as lifeboat men, the number of applicants rejected, and the number of certificates issued during the year ended June 30, 1930:

By whom issued	Applications received	Applications rejected	Certificates issued	By whom issued	Applications received	Applications rejected	Certificates issued
Local inspectors of vessels:				Local inspectors of vessels—Continued.			
San Francisco, Calif.	544		544	Juneau, Alaska	213	4	209
Los Angeles, Calif.	35		35	St. Michael, Alaska	3		3
Portland, Oreg.	17	3	14				
New York, N. Y.	273		273	Total by local inspectors	9,366	4,737	4,629
Albany, N. Y.	11		11				
Philadelphia, Pa.	25		25	Navy Department:			
Norfolk, Va.	19		19	Navy yards—			
Baltimore, Md.	137		137	New York, N. Y.	217	161	56
Jacksonville, Fla.	316		316	Portsmouth, Va.	72	6	66
Savannah, Ga.	100	15	85	Receiving station,			
Boston, Mass.	228		228	Philadelphia, Pa.	159		159
Bangor, Me.	37		37	Naval training station, Newport,			
New London, Conn.	111		111	R. I.	1		1
Portland, Me.	2		2	U. S. Coast Guard,			
Providence, R. I.	262		262	Treasury Department	3,992	1,200	2,792
Detroit, Mich.	236		236	Coast and Geodetic Survey, Department of			
Chicago, Ill.	7		7	Commerce	10	1	9
Duluth, Minn.	4		4	Bureau of Lighthouses,			
Grand Haven, Mich.	1		1	Department of Commerce	684	126	558
Marquette, Mich.	1		1	Massachusetts nautical			
Cleveland, Ohio	92	20	72	school ship Nantucket	45		45
Buffalo, N. Y.	4		4				
Toledo, Ohio	18		18	Total, 1930	14,546	6,231	8,315
New Orleans, La.	62		62	Total, 1929	11,785	3,960	7,825
Galveston, Tex.	16		16				
Mobile, Ala.	70		70	Increase	2,761	2,271	490
San Juan, P. R.	2		2				
Tampa, Fla.	30		30				
Seattle, Wash.	6,469	4,695	1,774				
Hoquiam, Wash.	21		21				

LIVES LOST ON VESSELS SUBJECT TO INSPECTION

The statement following shows the loss of life on vessels subject to inspection during the year ended June 30, 1930:

Cause	First		Second		Third		Fourth		Fifth		Sixth	
	Passengers	Crew	Passengers	Crew	Passengers	Crew	Passengers	Crew	Passengers	Crew	Passengers	Crew
Fire:												
Passenger steamers	----	----	----	----	----	----	----	----	----	----	----	1
Nonpassenger steamers	----	----	----	18	----	----	----	----	----	----	----	----
Collision:												
Passenger steamers	63	20	----	----	----	3	----	----	17	14	----	----
Nonpassenger steamers	----	----	----	2	----	2	----	----	----	19	----	----
Grounding: Nonpassenger steamers	----	----	----	1	----	----	----	----	----	----	----	----
Explosion, escape of steam, etc.: Nonpassenger steamers	----	----	----	4	----	----	----	----	----	----	----	1
Sinking: Nonpassenger steamers	----	----	----	4	----	----	----	----	----	----	----	1
Accidental drowning:												
Passenger steamers	----	4	4	6	2	5	----	1	----	----	----	----
Nonpassenger steamers	----	4	----	10	----	7	----	3	----	6	----	2
Suicide:												
Passenger steamers	7	1	9	----	2	1	----	----	2	----	----	----
Nonpassenger steamers	----	4	----	2	----	----	----	----	----	----	----	----
Miscellaneous:												
Passenger steamers	3	7	3	4	2	1	----	1	1	1	----	----
Nonpassenger steamers	----	12	----	10	----	6	----	----	[1] 2	3	----	----
Total:												
Passenger steamers	73	32	16	10	6	10	----	2	20	15	----	1
Nonpassenger steamers	----	20	----	51	----	15	----	3	2	28	----	4
Grand total	73	52	16	61	6	25	----	5	22	43	----	5
Last year	19	36	22	60	12	22	5	5	2	47	1	4
Increase (+) or decrease (−)	+54	+16	−6	+1	−6	+3	−5	----	+20	−4	−1	+1

Cause	Seventh		Eighth		Ninth		Tenth		Eleventh		Total	
	Passengers	Crew	Passengers	Crew	Passengers	Crew	Passengers	Crew	Passengers	Crew	Passengers	Crew
Stranding: Nonpassenger steamers	----	----	----	5	----	----	----	----	----	----	----	5
Fire:												
Passenger steamers	----	----	----	----	----	----	4	4	----	----	4	5
Nonpassenger steamers	----	----	----	----	----	----	----	----	----	----	----	18
Collision:												
Passenger steamers	----	----	----	----	----	----	----	----	----	----	80	37
Nonpassenger steamers	----	----	----	9	----	----	----	----	----	----	----	32
Grounding: Nonpassenger steamers	----	----	----	----	----	----	----	----	----	----	----	1
Explosion, escape of steam, etc.:												
Passenger steamers	----	----	----	----	----	----	----	----	----	1	----	1
Nonpassenger steamers	----	----	----	3	----	----	----	----	----	----	----	8
Foundered in storm: Nonpassenger steamers	----	----	----	25	----	----	----	14	----	----	----	39
Sinking:												
Passenger steamers	----	----	----	9	----	----	----	----	----	----	----	9
Nonpassenger steamers	----	----	----	47	----	2	----	1	----	----	----	55
Accidental drowning:												
Passenger steamers	----	----	1	1	----	1	1	1	----	----	8	19
Nonpassenger steamers	----	----	----	6	----	5	----	14	----	----	----	57
Suicide:												
Passenger steamers	----	----	5	----	----	1	7	----	----	----	32	3
Nonpassenger steamers	----	----	----	----	----	----	----	5	----	----	----	11
Miscellaneous:												
Passenger steamers	----	----	----	1	----	1	----	1	1	----	10	17
Nonpassenger steamers	----	2	----	1	----	2	----	2	----	----	2	38
Total:												
Passenger steamers	----	----	6	11	----	3	12	6	1	1	134	91
Nonpassenger steamers	----	2	----	96	----	9	----	36	----	----	2	264
Grand total	----	2	6	107	----	12	12	42	1	1	136	355
Last year	3	11	5	24	2	15	8	28	7	3	86	255
Increase (+) or decrease (−)	−3	−9	+1	+83	−2	−3	+4	+14	−6	−2	+50	+100

[1] Stowaways.

The total number of lives lost from all causes, passengers and crew, was 491, an increase of 150 over the previous year. Of the lives lost, 182 were from suicide, accidental drowning, and other causes beyond the power of the service to prevent, leaving a loss of 309 fairly chargeable to accidents, collisions, founderings, etc.

LIVES SAVED

During the year, 564 lives were directly saved by means of the life-saving appliances required by law.

ACCIDENTS RESULTING IN LOSS OF LIFE

The total number of accidents resulting in loss of life during the past year was 171, a decrease of 89 from the previous year. Enumerated by supervising inspection districts, accidents occurred as follows: First, 30; second, 45; third, 23; fourth, 4; fifth, 13; sixth, 4; seventh, 2; eighth, 18; ninth, 10; tenth, 20; eleventh, 2.

The following disasters resulted in an unusually large loss of life:

On August 29, 1929, the tanker *S. C. T. Dodd*, 7,054 gross tons, and the passenger steamer *San Juan*, 2,152 gross tons, collided 15 miles southeast of Pigeon Point, Calif., which accident resulted in the sinking and total loss of the *San Juan*, and the loss of 55 of her passengers and 20 of her crew. Damages to the steamer *S. C. T. Dodd* amounted to $7,045, and the *San Juan*, valued at $55,000, cargo $60,000, was, as stated above, a total loss. The case was investigated by the local inspectors at San Francisco, Calif., and charges were preferred against Hugo O. Bleumchen, master, and Otto V. Saunders, third mate of the steamer *S. C. T. Dodd*, and Robert Papenfuss, third mate of the steamer *San Juan*. The charges against Hugo O. Bleumchen were not sustained, but those against Otto V. Saunders and Robert Papenfuss were sustained, the license of the former being suspended for 1 year and the license of the latter being revoked.

On September 9, 1929, the steamer *Andaste*, of 1,439 gross tons, while en route from Grand Haven, Mich., to Chicago, Ill., with a crew of 25 and a cargo of gravel, was lost. Cause of the foundering was not ascertained. Vessel valued at $100,000.

The car ferry steamer *Milwaukee*, of 2,933 gross tons, left the port of Milwaukee October 22, 1929, bound for Grand Haven, Mich., and has never been heard from since. Wreckage and bodies of members of the crew proved conclusively that this steamer foundered, but actual cause is not known as there are no survivors. Forty-seven lives were lost. Estimated value of vessel, $720,000.

On October 29, 1929, the steamer *Wisconsin*, of 1,921 gross tons, sank 4 miles offshore from Kenosha, Wis., resulting in the loss of 9 of the crew. The vessel, valued at $200,000, was a total loss, as well as the cargo, valued at $125,000.

On October 31, 1929, the steamers *Senator* and *Marquette* collided 20 miles east of Port Washington in Lake Michigan, resulting in the sinking of the *Senator* and the loss of 9 of her crew. The case was investigated by the local inspectors at Milwaukee, Wis. Charges were preferred against Capt. Walter F. Amsbary, master of the steamer *Marquette*, which were sustained and his license suspended for 6 months. An appeal was made and the decision afterwards modified to 3 months. Estimated amount of damage, $275,000.

On November 30, 1929, the steamer *Kiowa*, 2,309 gross tons, grain laden, stranded west of Au Sable Point, Lake Superior. Five of the crew were lost, and 18 were saved by Grand Marais coast guards. Capt. Arthur J. Cronk, master of the *Kiowa*, was tried by the local inspectors at Detroit, Mich., in connection with the stranding, and his license was suspended for 60 days, but the suspension was afterwards modified to 30 days upon appeal to the supervising inspector of the eighth district. The steamer, valued at $100,000, was a total loss.

On January 28, 1930, the steamer *Edgar F. Coney*, 153 gross tons, with the barge *Pure Detonox* in tow, left Sabine Bar bound for Pensacola, Fla. The tug and barge encountered very rough seas and high winds, and some time during the night the tug disappeared from the view of the crew of the barge after hawser had been broken or cast adrift. The entire crew of the tug, 14 persons, lost their lives. Only one body was recovered. On January 31 the barge was picked up and towed to Pensacola by the steamer *W. E. Hutton*.

On February 16, 1930, the seagoing barge *Carroll*, one of three barges in tow of the tug *Montrose*, bound from Norfolk, Va., to New York, N. Y., sank during a severe storm south by west of Five Fathom Bank Lightship. The master of the *Carroll* and crew of three were lost. The case was investigated and dismissed by the local inspectors at New York, N. Y.

On March 2, 1930, while the steamer *Scantic* was docked at Alabo Warehouse Dock, Mississippi River, New Orleans, La., fire started among bales of cotton on the dock. Because of a high wind blowing from shore, the fire spread to the vessel so quickly that it was impossible for those on board to leave by the gangplank or to lower a lifeboat. Four members of the crew and three women and a child, who were visiting the ship, lost their lives. Approximate damage to steamer, $75,000. The case was investigated and dismissed by the local inspectors at New Orleans, La.

On April 24, 1930, the freight steamer *Thames*, 560 gross tons, bound from New York, N. Y., to Bridgeport, Conn., caught fire from some unknown cause and, after being beached off Sound Beach, burned to the water's edge. Sixteen of the 26 members of the crew lost their lives. The vessel was owned by the Thames River Line, New York, N. Y., and was valued at $15,000. The cargo, which consisted of sugar, oil, and excelsior, was valued at $30,000. The case was investigated by the local inspectors at New Haven, Conn., and dismissed.

On June 10, 1930, the steamer *Fairfax*, 5,649 gross tons, collided with the motor ship *Pinthis*, 1,111 gross tons, in the vicinity of No. 4 Gas Buoy, Massachusetts Bay, resulting in an explosion on the *Pinthis* and her immediate sinking with all hands (19) on board. A fire then broke out on the steamer *Fairfax*, as a result of which 14 of her passengers and 17 of her crew were lost. The fire was later extinguished. The case is under investigation by the local inspectors at Boston, Mass.

PASSENGERS CARRIED

During the fiscal year 317,231,352 passengers were carried on steam vessels that are required by law to report the number of passengers carried. Dividing this number by 136, the total number of passengers lost, shows that 2,332,583 were carried for each passenger lost. In

connection with the prevention of overloading of vessels, 3,245,411 passengers were counted during the year by representatives of this service.

EXAMINATIONS FOR COLOR BLINDNESS

During the year, 7,323 applicants for original licenses and for renewals of licenses were examined for visual defects, 41 of whom were found color blind, or had other visual defects, and were rejected, and 7,282 were passed. As compared with the previous year, these figures show an increase of 392 in the number examined and 383 in the number passed.

WORK PERFORMED BY INSPECTORS IN CENTRAL OFFICE

The following statement embraces work performed by the inspectors in the central office during the fiscal year.

Vessels inclined	93
Offsets measured and calculations made	99
Reinspections of vessels	186

MISCELLANEOUS REPORTS

The following statement embraces various matters and occurrences relating to the work of the Steamboat Inspection Service for the year ended June 30, 1930:

VESSELS

Vessels from which certificates of inspection were withdrawn	9
Vessels refused certificates of inspection:	
Domestic steam vessels	77
Domestic vessels propelled by gas, fluid, naphtha, or electric motors	9
Domestic vessels and barges of over 100 gross tons carrying passengers for hire, other than steam, motor, and sail vessels	1
Foreign steam vessels	1
Total	97

BOILERS

Boilers inspected:	
Steel (riveted plates)	10,182
Iron (riveted plates)	67
Pipe	2,313
Total	12,562
Boilers found defective:	
Gave way under hydrostatic pressure—	
Steel (riveted plates)	337
Iron (riveted plates)	1
Pipe	3
Total	341
Defective from other causes—	
Steel (riveted plates)	1,933
Iron (riveted plates)	20
Pipe	233
Total	2,186

Boilers condemned from further use:	
Steel (riveted plates)	40
Pipe	2
Total	42
Defects in boilers and attachments:	
Sheets	1,350
Heads	243
Steam and mud drums	61
Flues and tubes	92,372
Steam pipes	205
Stay bolts	43,752
Braces	606
Other parts	33,820
Total	172,409
Tests of samples of steel and iron plates to be used in marine boilers, other than material tested at the mills by assistant inspectors: Samples tested	12
Tests of samples of steel bars to be used as stays and braces: Samples tested	74

OFFICERS

Licenses suspended	182
Licenses revoked	20
Licenses refused	189
Licenses canceled	17
Violations of the law:	
Cases investigated	1,324
Cases dismissed	987
Cases reported to district attorneys and chief officers of customs	274
Number of appeals from decisions of local boards	29
Decisions of local boards reversed by supervising inspectors	4
Decisions of local boards modified by supervising inspectors	10
Decisions of local boards sustained by supervising inspectors	15

VESSELS LOST

Vessels under the jurisdiction of the Steamboat Inspection Service wrecked or foundered:	
Steam vessels	57
Motor vessels	21
Sail vessels	1
Barges, etc	12
Total	91

PROPERTY LOST

Value of property lost:	
By explosion or accidental escape of steam	$148,739
By wreck or founder	6,717,387
By collision between vessels	3,295,411
By fire	3,034,213
By snags	160,452
From miscellaneous causes	2,840,633
Total	16,196,835

Very truly yours,

DICKERSON N. HOOVER,
Supervising Inspector General.

PATENT OFFICE

DEPARTMENT OF COMMERCE,
UNITED STATES PATENT OFFICE,
Washington, July 1, 1930.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: I have the honor to submit the following report of the business of the Patent Office for the year ended June 30, 1930.

The fiscal year just ended was the biggest year the Patent Office has ever known. The total receipts amounted to over $4,000,000, or $300,000 more than the previous "peak" year, 1929. Four thousand more patent applications were received than during the previous year, the number amounting to over 91,000, while the total number of applications, including trade-marks, amounted to nearly 118,000. The number of patents granted was nearly 6,000 more than the previous year, reaching a total of almost 50,000. The total number of issues, including trade-marks, etc., was 69,000.

Last year inventors filed for record in the Patent Office over 5,000 assignments, licenses, etc., more than during the previous year, the total number being 57,000.

The Patent Office "10-cent store" also did a phenomenal business since the number of printed copies of patents disposed of during the year increased from 6,405,000 to 7,153,000, or 17 per cent. In fact, the number of these printed copies disposed of as compared with two years ago, when the number was 5,595,000, shows an increase of 1,558,000, or 27.8 per cent. This means that each day the Patent Office disposed of 5,000 copies more than it did two years ago, the total reaching almost 25,000 each working day. In addition to these printed copies, the Patent Office made nearly 1,000,000 photostats last year.

A year ago the United States Bureau of Efficiency made a study of Patent Office conditions and submitted certain recommendations looking toward a reorganization. A conference of patent lawyers meeting in Cleveland and known as the Cleveland conference, consisting of a representative from each of the patent law associations in the country, also made a study of Patent Office conditions, recommending certain changes for improving the service. The patent section of the American Bar Association also has had committees studying the Patent Office.

All these efforts and recommendations have resulted in appropriations sufficient to reorganize the office on the plan suggested by the Bureau of Efficiency, to furnish the Patent Office with another assistant commissioner, 3 more members of the board of appeals, 4 supervisors to aid the commissioner in a closer supervision of the sixty-odd divisions in the Patent Office, and to furnish in addition to these officials 100 more technical employees.

Some quite radical changes are being made to carry out the recommendations of the three organizations above referred to. The 4 supervisors will establish closer supervision of the work of each of the 63 divisions of the office, by unifying and integrating the administration of the bureau, by establishing a well-organized system of training for new examiners, by cooperating with the commissioner in forming a board of promotions, and by making certain other changes in methods. These supervisors are to be given neither administrative nor appellate power but are to cooperate and advise with the principal examiners. The supervisors have divided the examining divisions into groups, each supervisor inspecting the work of certain divisions in such a manner as to make sure that the methods of procedure and of carrying on the examining work are uniform so far as practicable and will produce the best results.

The interference practice also has been radically changed. Heretofore when a motion was made to dissolve an interference or to amend the issue of the interference, such motion was heard by a law examiner while the question of priority raised by the interference would be decided by the examiner of interferences. The new method of handling interferences consists in having three examiners of patent interferences instead of one and of having all motions decided by such examiners instead of by the law examiners. This makes it possible for the examiner of interferences who first takes jurisdiction of and hears any motion in an interference to continue in charge of that interference until it is finally determined. It is believed this will make for more efficient administration.

The increase of membership on the board of appeals will make it possible for that board to catch up with its work. Already improvement is noted. The board of appeals now has on hand awaiting action over 3,061 ex parte appeals and 347 interference appeals, a total of 3,408. The new members of the board are specializing on the ex parte appeals and appeals on interference motions with the hope of bringing these rapidly up to date.

The additional personnel will cost the Government over $400,000. The deficit for the past year amounted to $455,000. In order to provide funds to pay for the additional personnel and to avoid the deficit, Congress has increased the filing fee on patent applications from $20 to $25 and on trade-mark applications from $10 to $15, and has also increased the final fee on patent applications from $20 to $25. It is estimated that this will bring into the office approximately $850,000 additional income each year and thereby again make the office substantially self-sustaining as it was every year from President Lincoln's administration until this country entered the World War in 1917.

During the past year the principal examiners have been placed in grade 6 of the professional service and the Personnel Classification Board has opened up grade 4 of the same service so that if sufficient funds are available the office will eventually be able to have one examiner in each division in this grade. This will certainly tend to lessen resignations. It is again strongly recommended that appropriations be made so that it will be possible for the Patent Office to promote the examiners into grade 2, professional, at the end of two years' satisfactory service and to promote assistant examiners from grade 2

to grade 3 at the end of three years' satisfactory service. It is extremely costly to spend several years in educating a man for a particular job and then have him resign to accept a few hundred dollars more in outside employment.

Owing to the increase of fees above referred to, which became effective on June 1, 1930, the Patent Office receipts in May broke all records. The largest number of patents issued in any one week previous to this time was 1,091. So many applicants paid their final fees in May in order to save the additional $5 that in one week alone there were 3,174 patents issued, so that the Official Gazette was between three and four times its normal size. This and the receipt of several thousand new applications more than the normal taxed this office to the utmost, requiring the employees to work overtime and also taxed the Government Printing Office and the private firm of photolithographers who do the photolithographic work. To the credit of all it may be said that the large issue came out exactly on time. When it is realized that the Official Gazette is the biggest periodic publication issued by the Government, including each week about 275 pages and over 1,200 original cuts, it is a matter of great satisfaction to this office, and it must be to the Government Printing Office also, that for a number of years now this Gazette has been issued each Tuesday—whereas in former years it was frequently late, sometimes as much as a week or 10 days, which made it necessary to issue the Official Gazette under two dates, one the date of issue of the patents and the other the date the publication was actually issued.

The office closed the fiscal year with 119,597 new and amended applications awaiting action and with applications waiting an average of seven months for official action. Notwithstanding this, it is gratifying to note that all trade-mark applications and all design-patent applications receive official action in one month in new cases and within two weeks in amended cases. Because tastes in styles and amusements change so rapidly that patents relating to them are often valueless if not obtained promptly, the office has made special efforts to have all apparel cases and all simple games and puzzle applications acted upon as promptly as possible.

With the appropriation provided by Congress to make possible the increase in personnel above noted, the Patent Office is looking to the coming year for a large reduction in the number of applications awaiting official action by the examiners and on appeal and to a very material reduction in the time required for such action. It is hoped that eventually the Patent Office will reduce the average time that an application must await official consideration from seven months as at present to approximately 60 days or less.

Following is an appendix giving the usual statistical report.

APPENDIX

STATISTICS

Applications received during the fiscal year ended June 30, 1930 [1]

With fees:		
Applications for patents for inventions	91, 430	
Applications for patents for designs	4, 363	
Applications for reissues of patents	434	
		96, 227
Applications for registration of trade-marks	[2] 18, 617	
Applications for registration of labels	1, 868	
Applications for registration of prints	857	
		21, 342
Total, with fees		117, 569
Without fees: Applications for inventions (act Mar. 3, 1883)		221
Grand total		117, 790

Applications for patents for inventions with fees

Year ended June 30—		Year ended June 30—	
1921	84, 248	1926	80, 682
1922	88, 243	1927	84, 511
1923	77, 645	1928	88, 482
1924	76, 024	1929	87, 039
1925	77, 926	1930	91, 430

Applications for patents, including reissues, designs, trade-marks, labels, and prints with fees

Year ended June 30—		Year ended June 30—	
1921	107, 656	1926	110, 030
1922	113, 597	1927	113, 783
1923	100, 724	1928	116, 844
1924	99, 574	1929	114, 496
1925	103, 591	1930	117, 790

Patent applications awaiting action

June 30—		June 30—	
1921	49, 334	1926	43, 765
1922	67, 367	1927	64, 646
1923	72, 475	1928	106, 575
1924	60, 334	1929	103, 236
1925	44, 556	1930	119, 597

Patents withheld and patents expired

	1929	1930
Letters patent withheld for nonpayment of final fees	8, 565	8, 320
Applications allowed awaiting payment of final fees	19, 576	15, 232
Patents expired	34, 254	35, 057
Applications in which issue of patent has been deferred under sec. 4885 R. S.	168	554
Applications in process of issue	3, 323	3, 140

[1] Including applications in which fees were refunded and transferred.
[2] Includes 1,752 applications for the renewal of trade-mark registration.

Patents granted and trade-marks, labels, and prints registered

	1926	1927	1928	1929	1930
Letters patent	46,464	43,244	41,067	43,617	49,599
Design patents	2,763	2,478	2,698	3,201	2,598
Reissue patents	268	293	349	329	374
Trade-marks	14,235	14,858	14,219	14,391	13,897
Labels	1,676	1,782	1,857	1,774	1,610
Prints	868	1,074	944	933	723
Total	66,275	63,729	61,134	64,245	68,801

Statement of receipts and earnings for the fiscal year ended June 30, 1930

Unearned balance at close of business June 30, 1929			$159,714.21
Receipts for fiscal year ended June 30, 1930		$4,038,210.30	
Receipts from sale of Official Gazette and other publications through Government Printing Office		58,615.13	
Total receipts			4,096,825.43
			4,256,539.64
Earnings:			
Inventions, first fees	$1,853,560.00		
Extra claims	47,176.00		
Reissues	13,020.00		
Designs	49,240.00		
Design extensions	17,665.00		
Trade-marks	187,750.00		
Labels and prints	13,860.00		
Total		2,182,271.00	
Final fees	994,470.00		
Extra claims	26,694.00		
Total		1,021,164.00	
Appeals	43,565.00		
Oppositions	8,160.00		
Disclaimers	660.00		
Total		52,385.00	
Printed copies, etc	412,161.75		
Photoprints	12,814.10		
Photostats	74,485.95		
Manuscript	87,718.35		
Certified printed copies, etc	9,305.30		
Recording articles of incorporation	837.00		
Recording international trade-marks	45.00		
Registration of attorneys	785.00		
Total		598,152.45	
Drawings		24,264.20	
Assignments		111,805.60	
Total		3,990,042.25	
Receipts from sale of Official Gazette, etc		58,615.13	
Total			4,048,657.38
Refunded			26,163.47
Unearned balance June 30, 1930			181,718.79
			4,256,539.64

Expenditures, fiscal year ended June 30, 1930

Salaries		$3,095,351.08
Scientific library		7,902.52
Investigating public use		468.84
Photolithographing:		
Current issue	$78,586.71	
Reproduction	114,164.95	
Photographic printing	19,668.75	
Photostat supplies	46,438.73	
Dry mounts	1,886.07	
Total		260,745.21
Printing and binding:		
Specifications	852,174.77	
Official Gazette	177,585.87	
Indexes	10,239.36	
Total		1,040,000.00
Miscellaneous		60,000.00
Furniture and filing cases		57,088.41
Contingent expenses, including telephones, stationery, postage on foreign mail, etc		31,129.35
Total		4,552,685.41

Receipts and expenditures

Total receipts from all sources	4,096,825.43
Expenditures	4,552,685.41
Deficit	455,859.98
Total net surplus to date	5,883,728.66

Comparative statement

June 30—	Receipts	Expenditures	Surplus
1921	$2,712,119.69	[1] $2,640,373.96	$71,745.73
1922	2,894,286.58	[1] 2,722,205.37	172,081.21
1923	3,026,486.36	[1] 3,112,022.07	−85,535.71
1924	3,042,276.22	[1] 3,273,341.37	−231,065.15
1925	3,271,253.89	3,775,476.97	−504,223.08
1926	3,457,774.53	3,857,952.11	−400,177.58
1927	3,524,155.55	3,769,604.03	−245,448.48
1928	3,705,338.31	3,839,771.66	−134,433.35
1929	3,783,481.65	4,391,860.16	−608,378.51
1930	4,096,825.43	4,552,685.41	−455,859.98

[1] Including increase in compensation (bonus).

Litigated cases

Oppositions instituted	804
Cancellations instituted	163
Interferences declared (including 176 trade-mark)	1,716
Interferences heard (including 329 trade-mark)	535
Interferences disposed of before final hearing (including 839 trade-mark)	2,171
Interferences disposed of after final hearing (including 321 trade-mark)	526
Interferences awaiting decision (including 23 trade-mark)	53

Oldest case awaiting action, April 30, 1930.

To board of appeals:		
Appeals in interference cases		353
Ex parte appeals		2,435
		2,788
Appeals in interference cases disposed of		355
Ex parte appeals disposed of		2,100
		2,455
Interference cases awaiting action		347
Ex parte cases awaiting action		3,061
		3,408

Oldest interference case awaiting action, April 17, 1930.
Oldest ex parte case awaiting action, May 15, 1930.

To the commissioner:		
Appeals in trade-mark interferences		5
Appeals in opposition cases		89
Appeals in cancellation cases		21
Appeals in ex parte trade-mark cases		52
Interlocutory appeals		11
Total		178
Petitions ex parte	5,882	
Petitions inter partes	56	
		5,938
Total		6,116
Cases disposed of by commissioner:		
Appeals in trade-mark interferences		5
Appeals in trade-mark oppositions		84
Appeals in trade-mark cancellations		18
Interlocutory appeals		11
Ex parte appeals in trade-mark cases		50
Total		168
Petitions		5,088
Total		5,256
To Court of Customs and Patent Appeals of the District of Columbia:		
Appeals in ex parte cases (including 6 trade-mark)		177
Appeals in interference cases (including 3 trade-mark)		73
Appeals in trade-mark oppositions		39
Appeals in trade-mark cancellations		8
Total		297

OTHER DETAILS OF BUSINESS FOR THE FISCAL YEAR

As to the volume of business, the office received during the year 96,227 applications for patents, reissues, and designs; 16,865 trade-mark applications and 1,752 applications for renewal of trade-mark registrations; and 1,868 label and 857 print applications; 217,084 amendments to patent applications, 8,250 amendments to design applications, and 23,007 amendments to trade-mark, label, and print applications.

The number of letters constituting the miscellaneous correspondence received and indexed was 441,732. In addition 43,122 letters were returned with information.

The number of printed copies of patents sold was 4,055,001; 1,448,874 copies of patents were shipped to foreign governments, and 1,228,814 copies furnished public libraries. The total number of copies of patents furnished was 7,153,268, including those for office use and other departments.

The office received for record 57,566 deeds of assignment.

The drafting division made 730 drawings for inventors, and corrected 18,766 drawings on request of inventors; 163,651 sheets of drawings were inspected, and 20,061 letters answered.

Typewritten copies of 4,664,300 words were furnished at 10 cents per 100 words. The office certified to 15,405 manuscript copies, and furnished 10,549 miscellaneous certified copies. The office also furnished 379,965 photostat copies of manuscript pages; 66,098 photographic copies, and 438,608 photostat copies of publications and foreign patents, for sale; 9,689 photostat-manuscript pages; 96 certified manuscript copies and 4,093 photostat copies for Government departments, without charge; 32,945 photostat and 15,760 photographic copies for use of the Patent Office; 16,694 photostat copies for sale through photoprint section, and 863 photostats for office use; also 105,741 photostats for assignments, grants and disclaimers; in all, 978,909 photostat and 81,858 photographic copies.

Very truly yours,

THOMAS E. ROBERTSON,
Commissioner of Patents.

BUREAU OF MINES

DEPARTMENT OF COMMERCE,
BUREAU OF MINES,
Washington, July 1, 1930.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: In response to your request I furnish the following condensed report on the work of the Bureau of Mines during the fiscal year ended June 30, 1930.

FINANCES

Total funds available to the Bureau of Mines for the fiscal year ended June 30, 1930, were $2,684,386.38. Of this amount, $2,590,956.85 was spent, leaving an unexpended balance of $93,429.53, due mainly to uncompleted work in the helium program, resulting in the carrying over of $90,800 of helium-plant funds as authorized expenditures for the fiscal year 1931.

On the regular work of the bureau, $2,225,007.70 was expended directly, this figure being subject to slight corrections due to unpaid obligations. In addition, for the helium program, which is purely service work for the Army and Navy and has no part in the regular work of the bureau, $291,016.38 was appropriated direct to the bureau, and $166,200 was transferred from the Army and Navy for the purchase, at cost, of helium produced by the bureau for these military-service branches.

Table 1 presents classified and complete information regarding the financial history of the bureau since its transfer to the Department of Commerce July 1, 1925. A complete statement of the distribution of congressional appropriations to branches and divisions within the bureau and the expenditure of these funds in 1930 by the various divisions of the bureau is given in Table 2.

Figure 1 shows the annual expenditures exclusive of service items and based entirely on regular duties and functions, and therefore presents the truer picture of the bureau's own activities since its establishment. The annual expenditures of the bureau are illustrated in the curves shown in Figure 2.

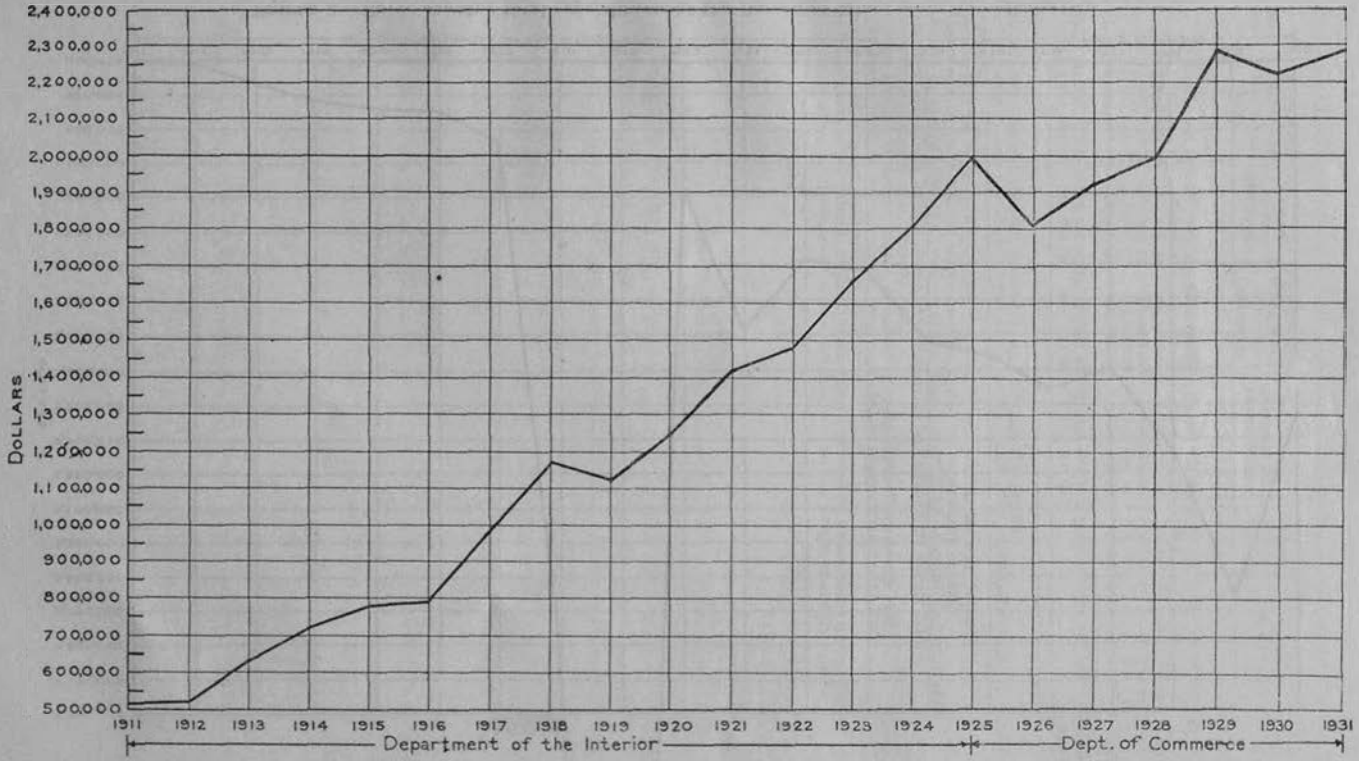

FIGURE 1.—Curve showing annual expenditure of the Bureau of Mines since its organization (exclusive of service items)

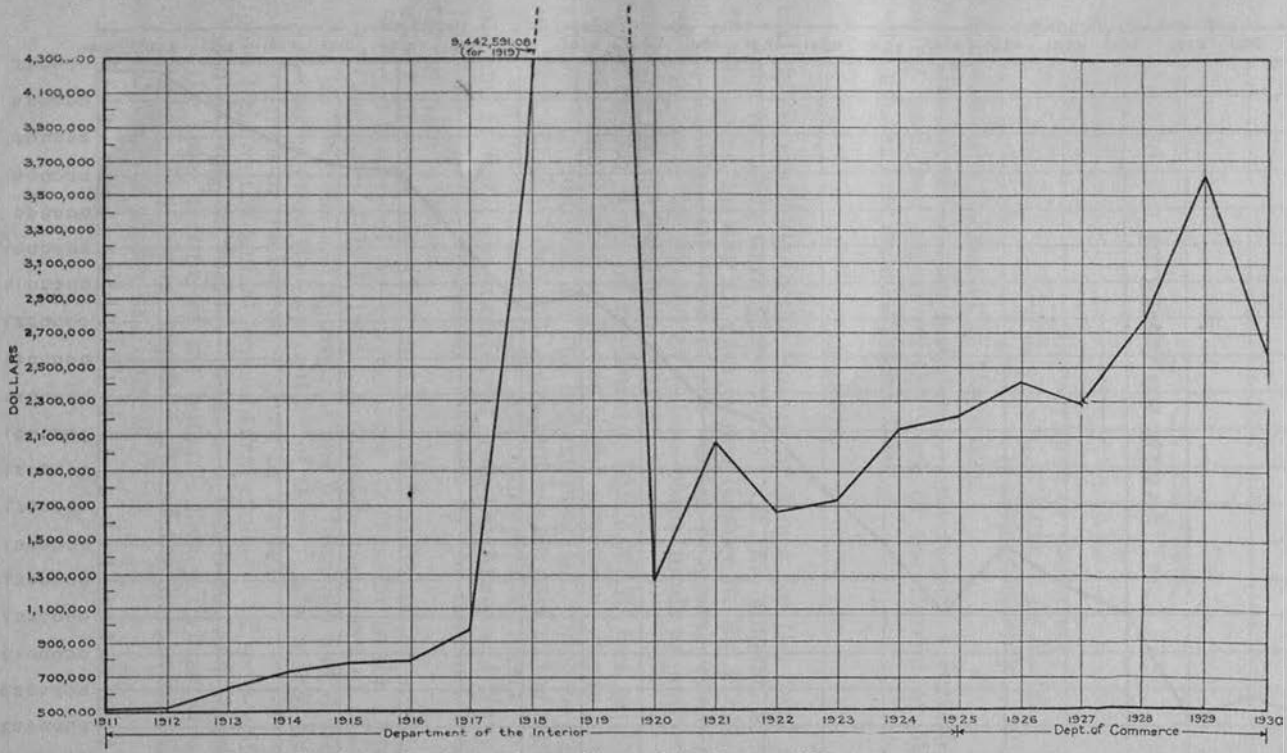

FIGURE 2.—Curve showing total expenditures of the Bureau of Mines since its organization

TABLE 1.—*Bureau of Mines appropriations and expenditures, fiscal years ended June 30, 1925–1930*

Fiscal year	Appropriated to the Bureau of Mines	Departmental allotments [1]	Funds transferred from other departments	Total funds available for expenditure	Unexpended balance	Total expenditures	Expenditures exclusive of service items [2]
1925	$2,028,268.00	$57,500.00	$236,465.86	$2,322,233.86	$107,743.20	$2,214,490.66	$1,998,669.20
1926	1,875,010.00	81,220.00	510,501.15	2,466,731.15	28,891.78	2,437,839.37	[3] 1,841,150.80
1927	1,914,400.00	94,443.39	325,000.00	2,333,843.39	44,871.29	2,288,972.10	1,926,910.12
1928	3,025,150.00	113,266.45	325,493.46	3,463,909.91	[4] 723,645.37	2,740,264.54	1,997,356.25
1929	3,444,594.67	103,000.00	205,500.00	[5] 3,753,094.67	[6] 129,405.85	3,623,688.82	[7] 2,283,284.16
1930	2,394,886.38	123,300.00	166,200.00	[8] 2,684,386.38	[9] 93,429.53	2,590,956.85	[10] 2,225,007.70
Total	31,508,022.05	1,312,450.96	14,725,000.47	47,545,473.48	4,200,360.30	43,345,113.18	27,105,828.09
1931	2,815,280.00	119,200.00	166,000.00	[11] 3,100,480.00			[12] 2,287,490.00

[1] Includes printing and binding, stationery, and contingent expenses.
[2] Service items include Government fuel yards, helium, and other investigations and services for other departments.
[3] Includes $122,229.39 for mineral resources originally budgeted to Interior Department.
[4] Balance of $719,476.67, helium plants, reappropriated for expenditure in 1929.
[5] Includes balance of $719,476.67, helium plants, reappropriated for expenditure during 1929.
[6] Balance of $120,216.38, helium plants, reappropriated for expenditure during 1930.
[7] Subject to adjustment until June 30, 1931.
[8] Includes $120,216.38, helium plants, reappropriated for expenditure during 1930.
[9] Unexpended balance, helium plants, reappropriated for expenditure during 1931.
[10] Subject to adjustment until June 30, 1932.
[11] Includes unexpended balance, helium plants, reappropriated for expenditure during 1931.
[12] Appropriations, allotments, and transfers (exclusive of service items) as of July 1, 1930.

TABLE 2.—*Bureau of Mines expenditures, fiscal year 1930*

Branch or division	General expenses	Mine accidents	Mining investigations in Alaska	Operating mine rescue cars and stations	Testing fuel	Mineral mining	Oil, gas, and oil-shale investigations	Expenses mining experiment stations	Care, etc., buildings and grounds, Pittsburgh
Office of the director	$13,839.02								
Office of the assistant to the director	8,717.46								
Office of the chief mining engineer		$45,795.59							
Office of the director, convention travel	2,993.86								
Administrative branch:									
Information division	47,723.77	18,765.21		$9,261.00	$6,414.94	$4,502.51		$1,834.93	
Office administration division	18,095.55	9,621.72		11,440.45	6,504.08	3,570.90	$4,478.86	8,865.17	
Total	65,819.32	28,386.93		20,701.45	12,919.02	8,073.41	4,478.86	10,700.10	
Technologic branch:									
Experiment stations division		97,724.01			57,440.22	3,875.87	7,424.39	75,735.30	$82,101.38
Explosives division		69,368.40							
Mechanical division		51,000.43	$11,158.56		108,645.06				
Metallurgical division						68,753.93		120,242.78	
Mining division		32,384.07				63,316.16		23,372.05	
Petroleum and natural-gas division							219,822.77		
Total		250,476.91	11,158.56		166,085.28	135,945.96	227,247.16	219,350.13	82,110.38
Health and safety branch:									
Health division		68,882.26							
Safety division		28,225.53		305,300.04					
Total		97,107.79		305,300.04					
Total appropriations	91,500.00	422,000.00	11,160.00	326,130.00	179,210.00	144,220.00	232,000.00	230,450.00	82,200.00
Total expenditures	91,369.66	421,767.22	11,158.56	326,001.49	179,004.30	144,019.37	231,726.02	230,050.23	82,101.38
Unexpended balance	130.34	232.78	1.44	128.51	205.70	200.63	273.98	399.77	98.62

Branch or division	Maintenance and operation Government fuel yards	Helium investigations	Investigating potash deposits	Economics of mineral industries	Helium plants	Helium production	Printing and binding	Department contingent	Total
Office of the director									$13,839.02
Office of the assistant to the director									8,717.46
Office of the chief mining engineer							$336.35		46,131.94
Office of the director, convention travel									2,903.86
Administrative branch:									
Information division					$533.25		5,191.14		94,226.75
Office administration division		$6,867.05		$16,644.25	4,281.65	$5,287.00	3,142.95	$30,850.27	129,649.90
Total		6,867.05		16,644.25	4,814.90	5,287.00	8,334.09	30,850.27	223,876.65
Technologic branch:									
Experiment stations division							5,633.77		327,676.08
Explosives division									69,368.40
Helium division		68,018.10			120,185.10	160,777.00	388.79		349,368.99
Mechanical division							2,402.72		173,206.77
Metallurgical division							5,705.09		194,701.80
Mining division			$100,000.00				2,038.41		223,369.55
Petroleum and natural-gas division							7,718.82		227,541.59
Total		68,018.10	100,000.00		120,185.10	160,777.00	23,887.60		1,565,233.18
Economics branch:									
Government fuel yards	[1]								
Coal division				55,174.49			3,503.65		58,678.14
Common metals division				28,583.73			1,913.60		30,497.33
Mineral statistics division				109,290.14			27,662.85		136,952.99
Petroleum economics division				37,359.64			4,123.53		41,483.17
Rare metals and nonmetals division				37,606.95			726.54		38,333.49
Total	[1]			268,014.95			37,930.17		305,945.12
Health and safety branch:									
Health division							39.10		68,921.36
Safety division							21,772.69		355,298.26
Total							21,811.79		424,219.62
Total appropriations	[1]	75,000.00	100,000.00	285,000.00	216,016.38	166,200.00	92,300.00	31,000.00	2,684,386.38
Total expenditures		74,885.15	100,000.00	284,659.20	125,000.00	166,064.00	92,300.00	30,850.27	2,590,956.85
Unexpended balance		114.85		340.80	[2] 91,016.38	136.00		149.73	93,429.53

[1] Revolving fund.

[2] Reappropriated for expenditure in 1931.

PROPERTY

The property records of the bureau, as of June 30, 1930, show accounts as follows:

Real estate	$1,169,990.00	Hardware and tools	$26,117.74
Laboratory equipment	394,217.40	Household equipment	17,056.85
Specialized equipment	401,750.30	Medical equipment	10,133.62
Office furniture and equipment	312,043.60	Engineering and drafting instruments	9,029.66
Power-plant equipment	615,293.99	Canvas and leather goods	3,619.53
Automotive equipment	77,049.36		
Electrical equipment	59,563.07	Total	3,122,295.79
Photograhpic equipment	26,430.67		

This property is in Washington and at the various field stations and offices of the bureau.

RECOMMENDATIONS

An additional sum of at least $10,000 for travel is required for distribution among 10 rescue cars and 60 persons in the field service if the bureau and the industry are to receive adequate service. The safety station at Jellico, Tenn., tributary to extensive producing coal fields in Tennessee and eastern Kentucky, to which only one man is now assigned, should be developed into a fully manned and equipped station, requiring an additional appropriation of $10,000. The work of the field men in the safety division, engaged in mine rescue and first-aid training, is seriously handicapped from a lack of sufficient mobility in travel; an appropriation of $5,000 for the purchase of passenger-carrying automobiles would greatly increase the efficiency of these employees. At least 90 per cent of the safety division force is engaged in safety work in coal mining, leaving the very important metal-mining industry with a minimum of attenton; an allotment of $10,000 is urgently needed to augment the safety force in the metal-mining industry. The important cement and quarrying industries have requested the cooperation of the bureau in the furtherance of the excellent safety work being done by those industries, and an allotment of $5,000 should be made for this work. Better progress in teaching safety in mining to the mine workers could be made by the use of talking moving pictures in the presentation of safety ideas; about $20,000 would defray the cost of making a 4-reel mine-safety film. The 100 active Holmes safety chapters, whose membership is made up of mineral workers, are doing creditable safety work, but require constant direct supervision to keep them functioning properly; an appropriation of $13,000 is needed for the employment of engineers who could be assigned to this work. At least $10,000 additional funds should be appropriated for repairs to mine rescue cars. A fund of $10,000 should be available to defray the cost of holding first-aid and mine rescue contests, which are highly important in keeping the safety idea alive in the minds of the miners.

Investigations should be conducted by the health division on the hazards of breathing dusts produced in the mining and metallurgical industries. These should include a complete laboratory study of the biochemical effect of silica dust and silicates to determine the

reactions caused by the dusts. Possible methods of diagnosis and prevention of pneumoconiosis of the lungs produced by breathing dust are well known, but the extent of the damage done is still in question. Silica dust is known to be harmful, rendering a man susceptible to tuberculosis. Recently the ill effects of exposure to asbestos dust and some of the silicates have been demonstrated. The extent of the hazard should be determined. This involves a program of three to five years at an annual cost of about $18,000.

While some preliminary work has been done to determine the effect of oxygen on the miner while wearing oxygen-breathing apparatus in rescue work for many hours daily, more careful study is required. This involves a program of two to three years at a cost of about $12,000 a year.

The bureau is constantly urged to undertake a survey of the by-product, gas, and coke making properties of American coals. A comprehensive study of this important problem would require an appropriation of $100,000. A truck, to cost $3,500, equipped with power-operated crushing machinery to obtain coal samples at the anthracite mines and breakers is badly needed.

It is urgent that the bureau extend its studies in the application of geophysical methods to prospecting for hidden deposits of minerals and oils, and for this purpose an increased appropriation of $50,000 is required. The sum of $50,000 is needed by the mining division for additional lines of investigation which promise important aid to the mining industry in reducing costs, increasing efficiency, and lessening the hazards of mining. These problems include the pumping of underground water under difficult conditions; remote transportation involved in prospecting and developing mines in outlying districts; technical and economic reports of smelting and other metallurgical operations; and the production and preparation of nonmetallic minerals.

Important research in the fundamentals of the flotation process has been discontinued, owing to lack of funds; an appropriation of $40,000 should be made for the continuance of this work. Fundamental research on classification and flotation, conducted by the bureau, which led to the recovery of approximately 10,000,000 pounds of copper per year formerly lost in Michigan tailings, has been discontinued because of lack of funds; an appropriation of $27,500 is required for continuance of this research. For fundamental research on the crushing and grinding of ores, important for lowering costs in milling operations, $32,500 should be provided. Funds are required for continuation of studies in the concentration of manganese from low-grade ores. The bureau has made good progress on this problem, but the work has been stopped because of lack of funds. The problem of economic concentration of the lower-grade iron ores of Minnesota, Michigan, and Alabama must be met by research if the United States is to remain independent of foreign iron ores, and the funds for the Federal Government's participation in this research should be provided. Owing to lack of money, the bureau has been unable to give proper attention to the preparation and beneficiation of numerous important nonmetallic minerals.

An additional appropriation of $9,600 is needed for the compilation of statistical summaries on the consumption and distribution of coke,

manufactured gas, and coal products, including nitrogen. The processing of coal for the production of coke and the recovery of gas, benzol, ammonia, and coal tar is a large industry, and there is urgent need for the collection of statistical data covering the materials named. An appropriation of $7,000 is asked to enable the making of statistical analyses of the domestic fuel market, which is changing rapidly through the competition of oil and gas with coal and the installation of small, automatic stokers. There is a demand from both producers and consumers of coal to place the present quarterly report on commercial stocks of coal and coke on a monthly basis in order to guide more accurately important policies in a $3,000,000,000 commodity; for this purpose an appropriation of $7,000 is asked. Statistical data regarding the present demands for liquid and gaseous fuels produced by the petroleum industry and a knowledge of the economic factors affecting their consumption are necessary. A fund of $30,000 is desired for this study. The series of economic papers prepared by the common metals division of the economics branch has made available for the first time analytical data covering the production and consumption of the major industrial metals over long periods. For increasing the number and speeding the publication of these papers, which have aroused great interest in the industry, an appropriation of $14,000 is required. Additional funds amounting to $25,000 are urged for investigating the economic relationship of silver to copper, lead, zinc, gold, etc., with respect to occurrence, production, metallurgical treatment, consumption, and price; this is for the purpose of indicating the effect of silver production in the general economy of the United States.

The rare metals and nonmetals division has prepared numerous information circulars containing complete information in regard to the production, consumption, occurrence, technology, economics, and uses of the various mineral materials included in the division's field; a fund of $11,500 is necessary to continue the publication of these circulars. For the preparation of data on the marketing, competitive conditions, substitute materials, trends in demand, new uses, lists of buyers, etc., in the field of minerals used for building materials additional funds of $7,000 are required. An appropriation of $13,000 is asked for the establishment of a new service as an aid to industrial development in the mineral-commodities field. For the compilation of special summaries of long-time production records of individual minerals commodities an appropriation of $10,000 is urged.

Finally, it may be said that there is a growing need for a mining-research plant where investigations can be conducted which require frequent personal contact with the bureau's division chiefs in Washington. The system of experiment stations scattered through the various mining districts needs supplementing by one near the National Capital.

PRINCIPAL ACTIVITIES DURING THE YEAR

The Bureau of Mines continued to make steady progress with its educational program looking toward the attainment of safer and more healthful working conditions among the employees of the Nation's great mineral industries. More than 112,000 employees

of the mining, quarrying, metallurgical, oil and gas, and allied industries were trained in first-aid or mine rescue methods, the number surpassing by approximately 31,000 that attained in any previous year and bringing the total number so trained by the bureau since its establishment to approximately 480,000. Many large mining concerns are manifesting their interest in this work by having these courses given to their entire working force, and during the year 181 mines or plants were given bureau certificates showing that 100 per cent of their employees had been trained.

The practice, consistently urged by the bureau, of thoroughly rock dusting bituminous coal mines to prevent or limit mine explosions continues to gain ground. Investigations of explosions made by bureau engineers, show conclusively that rock dusting is the most efficacious preventive measure known. As a result of this investigative work, the coal-mining industry is using an ever-increasing proportion of permissible explosives, which are far safer than other types. The same safety trend is noticeable in the continued increase in the use of permissible electrical mine equipment, tested and approved by the bureau. The bureau's list of permissible equipment now covers every activity for which such equipment is used. Substantial progress is being made in the special study of accidents in mines due to falls of roof and coal, which are responsible for approximately half of the fatal accidents in mines.

The cooperative agreement between the bureau and the British Safety in Mines Research Board, designed for the exchange of mine-safety information, continued to function satisfactorily. The health and sanitation problems affecting workers in the mineral industries were studied, especially with reference to poisonous gases and vapors, unwholesome dusts, and unhealthful conditions of temperature and humidity to which the miner is frequently exposed.

Continued widespread interest was manifested by the mining industry in the numerous reports on mining and milling methods and costs issued by the bureau. These reports present detailed data regarding conditions at representative operations in the various mining districts, and are designed to assist the operators in the solution of their problems. This work was extended during the year to the nonmetallic industries. The bureau continued its studies in geophysical prospecting, an important feature of this work being the issuance of monthly abstracts of the world's literature in this interesting field. Problems of mine subsidence and mine ventilation were studied.

The bureau continued to take an active part in the technologic progress of the metallurgical industry, seeking to focus attention upon wasteful or inefficient practices, pointing out improvements, and obtaining the cooperation of producers in adopting better methods and putting into use more efficient devices. The bureau is providing fundamental metallurgical data, which are vital to the progress of metallurgy. Studies in microscopy are affording information highly valuable in the treatment of the complex ores of the intermountain region. New light is being thrown on the metallurgy of copper, special attention being given to leaching problems. Practical help in the solution of their difficult milling problems is being extended to the lead and zinc operators of the Mississippi Valley.

Other studies of importance deal with the crushing and grinding of ores, and flotation fundamentals. Studies looking toward the development of a domestic chromite industry are in progress.

The bureau has continued its studies designed to obtain valuable fundamental data on the smelting of iron ores. Progress was made in the effort to develop methods for the profitable recovery of the manganese content of the low-grade manganiferous iron ores of northern Minnesota and for the beneficiation of various types of low-grade manganese ores. Studies of the physical chemistry of steel making, designed to eliminate unscientific and wasteful practices, were continued. Experience gained in the iron-blast-furnace investigations is being utilized in a study of the lead blast furnace, a matter of great importance to the lead industry.

Considerable attention is being given to problems in the mining, treatment, and utilization of the numerous important nonmetallic minerals, used to a large extent in general construction and engineering enterprises. Special attention was given to the problems affecting the phosphate, kaolin, mica, and ocher industries. New processes devised for the utilization of polyhalite for fertilizer purposes give promise of success; this mineral was found in large quantities in New Mexico and Texas, as a result of the bureau's exploration work.

The bureau continued the study of the problems of the petroleum and natural-gas industries, with a view to the development of more efficient methods of production, transportation, refining, and utilization of the products obtained from these natural resources. Special attention is being given to various processes looking toward the recovery of a larger percentage of oil in underground deposits, a matter of great importance when it is realized that only about 20 per cent of the oil in such deposits is now recovered. By conducting special engineering studies of important oil-producing fields, the bureau is assisting operators in their efforts to control underground waters that threaten the continuance of successful development. Studies are being conducted looking toward the reduction of the large annual evaporation losses of petroleum and gasoline. Problems affecting the flow of natural gas through pipe lines, and the gaging and controlling of natural-gas wells, are also being studied. Valuable information regarding the characteristics of representative crude oils from different parts of the United States, and the world in general, is being provided. Progress is being made in a study looking toward the utilization of the black oils of the Rocky Mountain region, hitherto largely undeveloped. Oil-shale studies were continued. An investigation designed to afford information regarding the obtaining of numerous valuable by-products from natural gas is in progress.

The new helium-production plant near Amarillo, Tex., produced almost 10,000,000 cubic feet of helium during the fiscal year—the largest amount ever produced in a like period. Cost of production of this rare, nonflammable gas, essential in the navigation of dirigibles, was much lower than ever before.

The bureau has continued to study efficiency in the use of fuels. This work includes the making of thousands of analyses of coals, the study of combustion, the utilization of low-grade fuels, the prevention of smoke, the study of new types of fuel, the preparation of coal,

and the carbonization of coal with attendant conservation of by-products. An important problem undertaken is the determination of the gas-making and coking characteristics of the different coals of the country. As the result of the bureau's fuel-economy service, large sums are being saved annually in the operation of Government heating and power plants.

In addition to studying the scientific and technical problems of the mineral industries, the bureau is giving increased attention to economic conditions and problems. This involves the collection and dissemination of statistical data regarding the production, consumption, distribution, and storage of the numerous essential minerals. The results of these statistical and economic studies are widely used by the mineral industries in keeping in close touch with market trends and in the solution of business problems.

Accidents to the men employed in the mineral industries of the country result annually in approximately 2,800 deaths and more than 200,000 lost-time injuries. The economics branch conducts statistical canvasses of the number and causes of accidents to persons employed in these industries. Information of this nature is essential to the study of effective means of accident prevention.

WORK OF THE TECHNOLOGIC BRANCH

MECHANICAL DIVISION

The mechanical division studies the efficient use of fuels, including the newer developments in fuel technology, such as the combustion of powdered coal and the low-temperature carbonization of coal. The bureau has analyzed thousands of coal samples and given attention to the use of new materials and new methods in the manufacture of illuminating gas, and to obtaining more and better by-products in the coking of coal. The results of this extensive program of investigation have been made public in numerous bulletins, which afford helpful information to the coal operator, the coal marketer, and the coal consumer.

The increasing electrification of coal mines has been attended by new hazards. The bureau investigates and tests electrical and other mining machinery and equipment, and has encouraged the development of permissible equipment, which, when properly used, reduces such hazards to a minimum.

ELECTRICITY IN MINES

The work of the electrical section at the bureau's Pittsburgh Experiment Station consists largely of tests of apparatus designed to meet the bureau's schedules for permissible equipment, covering the following subjects: Electric motors, switches, and junction boxes to be used in the operation of electrical equipment in mines; electric cap lamps, miscellaneous electric lamps, flash lamps for use in the presence of methane and gasoline vapors; portable methane detectors; single-shot blasting units; and electric locomotives.

These permissible schedules, which give the minimum requirements that must be met to win the bureau's approval as permissible, have

become essential in guiding the activities of the bureau along safety lines, in giving the manufacturer of safety equipment a definite goal, and in placing the approval work on a firm foundation. The permissible list now covers practically every line of activity for which equipment is used in underground coal mining.

During the year 22 approvals of mining equipment and apparatus have been made. Extensions of approvals previously issued have also involved a large amount of work.

The weakest element of portable electrical equipment in service has been proved to be the trailing cable by which current is conducted from the fixed source of supply. To assist in the development of better cables, laboratory tests of numerous types and makes of cables now in use have been made to show the methods of failure. Several new types, designed to overcome the defects in the older ones, have been submitted by the manufacturers and tested.

The points at which methane is ignited by different heated metals have been determined during the past year. The data obtained are of value in the study of the possibility of ignition of mine gases and petroleum vapors by overheated electrical conductors and resistance and starting equipment; they have been published in Technical Paper 475.

Electrical safety codes and regulations from various sources have been compared, and the relative emphasis placed on safety in the use of electrical equipment in coal mines in the various States and in certain European countries has been studied. A tentative code covering the installation and use of electrical equipment in coal mines has been compiled to assist the various States in revising their mining laws and to promulgate a uniform code governing the installation and use of electricity in coal mines.

EFFICIENCY IN THE USE OF FUELS

Fuel inspection and coal analysis.—The function of the fuel-inspection section is primarily determination of the fuel value of the coals of the United States; its duties include checking the quality of coal delivered to Federal departments and to any State and municipal institutions that will avail themselves of such assistance, and advice on the purchase of coal. Coal is also inspected and sampled in the mine, at the tipple, and in some instances at the point of delivery. Analyses are reported to the interested parties, and assistance is rendered in the preparation and execution of fuel contracts. Samples from numerous mines in Maryland, Pennsylvania, Virginia, Kentucky, and West Virginia, and of 26 cargoes of coal at tidewater piers, were collected and analyzed during the year.

The coal-analysis section analyzes samples of coal and coke purchased by the United States Government on specification. Similar work is carried on cooperatively with the States of Maine, Maryland, New York, and New Jersey, with various State geological surveys, with municipal governments, and with the American Gas Association and the American Society for Testing Materials. All coal samples collected by different sections of the bureau in their various investigations are likewise analyzed. Samples are exchanged with several commercial and industrial laboratories to

check methods of analysis; in consequence, a high standard is maintained at these laboratories. Analyses are often made of umpire samples and samples of coal intended for export. During the past fiscal year 117,849 determinations were made of 10,136 samples.

Fuel-economy service.—The fuel-economy service made power-plant studies, fuel-efficiency tests, fuel studies on proper selection of coal, and acceptance tests of new equipment, and acted in a consulting capacity on many problems of the Bureau of the Budget and various Government power plants, including the purchase of new equipment and the preparation of specifications, all with the object of saving fuel.

Large savings have been made for the Government in the operation of various heating and power plants by testing and altering equipment, training firemen, employing different firing methods, changing the grade of fuel used, etc. A survey of the heating equipment of the smallpox hospital in Washington, D. C., resulted in a saving of $14,800 in an appropriation for new equipment. At the Leavenworth (Kans.) Penitentiary, where it was proposed to expend $360,000 on the power plant, the bureau's studies showed that this expenditure was unnecessary. At the District of Columbia Crematorium it was found that an expenditure of $6,100 would suffice where $10,000 had been requested. A change in the boiler settings at the post office in Washington, D. C., resulted in the elimination of much smoke and a saving of $1,200 in the annual fuel bill.

Removal of ash in molten form from boiler furnaces.—Burning fuels in pulverized form introduces problems in the collection, removal, and disposal of the ash. Keeping the ash deposited in the furnace in a liquid form so that it can be tapped off has certain operating and economic advantages. The bureau has cooperated with a special research committee of the American Society of Mechanical Engineers in investigating fundamental factors connected with this wet method of operation. Studies of various coals burned in furnaces of large boilers showed that the method could not be used with coals having ash that fuses at high temperatures. A further study has been conducted to determine what fluxes may be employed to overcome this limitation and to make possible the extension of the method to all coals.

Use of fuels in brick kilns.—The successful and economical manufacture of ceramic ware depends largely on the operation of firing. In cooperation with the University of Ohio the bureau is extending its previous work on the burning of bricks, more particularly in kilns of older types. Investigations have included the burning of fuels in standard-type fire boxes and in a mechanical stoker. The investigators will attempt to determine the sources of troubles experienced in burning bricks, to show the possibility of overcoming these difficulties through control of the burning or through the fuel used.

Use of fuels for domestic purposes.—The quantity of coke used for domestic purposes has increased two and one-fourth times in the past four years. Many manufacturers of coke have been endeavoring to produce grades and sizes which they believe best suited to domestic furnaces; also to some extent new types of coke with a higher content of volatile matter have become available. To supply information to householders and to manufacturers of coke and domestic equipment,

an investigation was made to determine the results from using certain grades and sizes of cokes, also to find out what relative adjustments of dampers and what attention must be given to obtain similar results with different grades and sizes. A preliminary publication was issued giving the results of this work, and making available the information which was most needed. A similar study of anthracites has been partly completed.

An investigation is approaching completion on the possibility of increasing the efficiency of domestic furnaces or of improving their operation by supplying air over the fuel bed. Many devices on the market will, it is claimed, produce large savings of fuel; the investigation is to determine whether there are such possibilities.

Utilization of natural gas.—Where the supply of natural gas is limited and the normal supply is manufactured gas, it is an economical advantage to use the natural gas to take care of a peak load. A study was made in cooperation with a gas company to determine the feasibility of using their standard equipment for converting natural gas to one having the same characteristics as manufactured gas. This investigation was successfully concluded and a report issued.

Another investigation was carried out to determine the feasibility of utilizing standard equipment for making carbon black and of producing it more economically by making a residual gas that could be added to the normal supply of gas manufactured from solid fuel.

Burning small particles of pulverized fuel.—The combustion of small particles of carbon has been investigated by a novel method which involves bringing accurately shaped and weighed spheres of carbon to a known temperature in an inert gas, suddenly blasting the particles with an air stream of known velocity and temperature for a very short interval, quickly quenching the particles in inert gas, again weighing to determine the amount of reaction, and obtaining careful records of particle surface temperature during the combustion. In all cases the specific surface reaction rate increases with increasing particle surface temperature. This temperature coefficient and the specific surface reaction rate are enormously larger for the smaller particles than for those of larger size. The rate, of course, increases with increasing air velocity. The results have especial interest in connection with the design and operation of furnaces burning powdered fuel.

Useful products from waste natural gas.—The most efficient utilization of natural gas when it can not be used for fuel is being studied. One phase is an investigation of the production of formaldehyde by partial oxidation of natural gas in the presence of gaseous catalysts, such as oxides of nitrogen. This compound is used extensively in the manufacture of synthetic resins, from which many useful products are fabricated. Another phase of the investigation involves the production of liquid hydrocarbons suitable for motor fuel.

Removal of organic sulphur from gas.—In the manufacture of gas from coal, coke, or petroleum, sulphur occurs in the gas as hydrogen sulphide and also combined as carbon disulphide, mercaptans, and other organic compounds. A considerable amount of this sulphur must be removed before the gas can be used for heating. Removal is even more important when the gas is to be transformed into other

products by passage over a catalyst, because the sulphur acts as a catalyst poison. Hydrogen sulphide is easily removed by well-known methods, but a satisfactory process for removal of organic sulphur has not yet been developed. As part of the bureau's program for the better utilization of coal and natural gas, a fundamental study of methods of removing organic sulphur from gases is being made; the methods being experimentally investigated include catalytic removal and absorption by chemical reagents.

New tests of characteristics of coal.—An intensive coal-sampling campaign has been conducted to determine the fuel value and other important characteristics of Washington coals. Because all ranks from lignite to anthracite occur in that State the bureau has devised and for the first time applied other tests to the coals collected, in addition to the customary proximate and ultimate analyses. These tests will provide additional means for estimating the suitability of a coal for a particular use: (1) An accelerated slacking test for estimating the resistance to degradation on weathering in storage, (2) a procedure for determining the resistance to degradation or breakage on handling, (3) an agglutinating test which measures the probable suitability of a coal for use in manufacturing coke, and (4) a laboratory low-temperature carbonization assay for estimating yields of products by this method.

CARBONIZATION OF COAL—BY-PRODUCTS OF COAL

Effect of inert substances on coking properties of coal.—In general, excessive amounts of ash in coal are known to have a deleterious effect on its coking properties, but this effect has not been measured quantitatively. This investigation has endeavored to develop a method whereby such measurement can be made and to apply it in a study of the separate effect of the various ash inerts and fusain on coking power. A method for determining the fusain content of coal had previously been developed, and it was shown that 20 per cent in Pittsburgh-bed gas coal did not injure its coking properties. Later, the effect on coking power of the ash inerts, gypsum, pyrite, sand, and calcite was studied, Pittsburgh coal being used in the tests. The test showed that all these inert ash-making substances detract from the coking power of coal, the effect being directly proportional to the amount present. The specific deleterious effect for each inert is in the order given above.

Methods for determining gas and coke making properties of American coals.—At present there is no reliable source of systematic information as to yields and quality of products obtainable from American gas-making and coking coals. This investigation proposed, first, to develop a test procedure on a moderate and hence inexpensive scale for obtaining this information; second, to standardize the method to a few coals of known carbonizing properties; and, third, to apply it systematically to American coals.

Progress toward the ends in view may be summarized as follows: A test procedure involving carbonization of 80 to 90 pound charges of coal has been developed, which has been standardized by carbonization over both the low and high temperature carbonization ranges of three coals, the coke and gas making properties of which are

known. The results for these coals show close agreement for the most part with those obtained in industrial practice.

Plastic state of coal during coking.—The carbonization of coking coal takes place in three stages, approximately defined by temperature limits between which certain phenomena are observable: During the first stage (up to 330° C.) water and oxides of carbon are given off; during the second (330° to 500° C.) certain constituents of the coal melt and the mass becomes plastic, giving off gases and tars; during the third (500° to 1,000° C.) the coked mass shrinks and gives off a small amount of tar with considerable lean gas. The second stage of the process is of major interest, because the melting point of the coal, the plasticity of the mass, its setting temperature, and the amount of expansion taking place very largely determine the quality of coke produced. During the present study methods already developed for measuring the melting and setting temperatures of coal were used, and a new method was devised for measuring plasticity. This work is still in progress. The work of the past year, however, indicates in the main that (1) fluidity (or plasticity) parallels hydrogen content of the coal; (2) the most fluid coals are high in volatile matter; (3) high fusion and setting temperatures accompany high percentages of fixed carbon, low oxygen, and high shrinking temperature; (4) to produce good coke the infusible material in the charge must be wetted by the fusible constituents. The wetting must occur during the plastic period (stage 2), and the material that has fused must adhere to the infusible particles after the mass solidifies into coke.

Agglutinating power of coal.—A wide variety of methods has been proposed for study of the binding or agglutinating power of coal, but so far none has come into such general use as to be recognized as standard. The purpose of this work is to investigate the most promising methods proposed, interpret results obtained thereby, and ultimately develop a standard method. During the past year the Foxwell or Layng-Hawthorne method for studying binding power has been used. This is not a conventional method for agglutinating power; in addition to furnishing information on agglutinating power, the method gives information on decomposition temperature and plasticity. It involves measuring the resistance offered to the passage of nitrogen gas by a column of coal during carbonization.

The following conclusions are drawn from the tests made during the year: (1) It gives closely reproducible results, which run approximately parallel to results obtained by conventional methods; (2) it provides a sensitive means of detecting oxidation (or weathering) in coking coals; (3) it distinguishes sharply between the easily coking coals (for example, gas coals) and the viscous coking coals (for example, semibituminous).

MINING DIVISION

The work of the mining division relates principally to improvements in mining and milling methods, with the object of reducing loss and waste in mining and preventing accidents. The investigations of the division include such subjects as drilling and blasting,

the loading of ore and coal, mine timbering, the breaking and handling of ore and coal, mine ventilation, underground transportation, mine sampling, efficiency of mine labor, and mining and milling costs. The division is preparing an extensive series of reports based on detailed data regarding mining and milling methods and costs at representative mines in the different districts of the country furnished by the bureau's consulting engineers who are the managers and engineers in charge of these operations. It is believed that this free discussion of mining and milling problems in Government publications will aid operators to overcome technological and economic difficulties, and that it will help to increase metal or mineral recovery and reduce production costs. Special attention is being given geophysical prospecting, and extensive field investigations are in progress in various parts of the United States and Canada. Investigations are under way on falls of mine roof and coal. Considerable work has been done on the study of subsidence of land after mining. The bureau is exploring extensive areas in the Southwest in which beds of potash-bearing salts have been found, with a view to developing the domestic supply of potash.

Mining and milling methods and costs.—An investigation of mining methods, including the factors affecting costs and governing the procedure adopted, is being made in the principal mines of the United States. Papers on the subject have been and are being prepared by the engineers and managers of the particular mines selected for study in various mining districts. In these papers especial attention is given to the tonnage produced per man and per machine underground, to the unit-supply consumption, and to the problems of underground mine support and ventilation. These data will afford mine operators a basis for comparison with their own methods and costs, and will suggest improvements applicable to their own problems.

Methods and costs of mining and preparation of nonmetallics.—As a result of the realization that many of the methods for treating metals and nonmetals are similar, there has been an increased demand for detailed technical information regarding the mining and treatment methods employed in the recovery of nonmetals. To provide information of this nature, a nonmetallic section has been added to the mining division to investigate and study methods of mining, treatment, and costs paralleling that study in the field of metals. From information obtained from reports on individual operations, bureau engineers will study such phases of mining and treatment methods as stripping, drilling and blasting, loading and transportation, crushing, screening, washing, conveying, storing, management, safety, etc. By discussing and comparing methods employed under different and similar conditions it is hoped to supply to the nonmetallic industries technical information that will assist them in solving production problems and in reducing operating costs and waste.

Subsidence and ground-movement studies.—The investigation of subsidence and ground movement involves a study of the conditions of the occurrence of the ores and associated formations and their relation to failure of ground in open cut and underground operations. In this work, fundamental information affecting and controlling subsidence and ground movement is collected to determine the factors

involved and so to suggest precautionary and remedial measures to insure workings against failure and resulting damage.

Mine ventilation.—Ventilation surveys were made at the principal mines in Arizona, and detailed reports and recommendations were forwarded to the mine managers.

Tunnel-driving methods.—A detailed study has been undertaken of modern methods of tunnel driving. Unit costs for tunnels of various sizes and shapes, and in various rock formations, will be determined.

Geophysical methods of prospecting.—Since the efficiency of electrical-induction methods depends upon their ability to penetrate the ground before stimulating a conducting body, a study of the rate of decay of electromagnetic fields as they penetrate a partly conducting medium has been undertaken. The relative efficiency of the different frequencies for this purpose is being experimentally investigated at Mammoth Cave, Ky. A check of the theoretical relations to those experimentally observed has considerable importance in determining the limitations of these methods of prospecting. Very successful experiments on the direct location of oil deposits by electrical methods were made. The torsion balance is being tested with a view to shortening the time of observation in the field. Because of the very fine wire used in these instruments, the period of oscillation before coming to rest is rather long; curtailment of this period is desirable. An invesigation is under way to determine the ground vibration caused by blasting; the primary object is to measure the extent and nature of these vibrations and their effect upon buildings.

Falls of roof and coal.—The study of falls of roof and coal has been continued in the bituminous mines of Pennsylvania, Ohio, and West Virginia; such falls account for 50 per cent of all fatalities in coal mines. A manuscript for a report of investigations has been prepared; it covers the study of a number of mines in eastern Ohio, representing 60 per cent of the annual tonnage of the district. Similar manuscripts are in preparation covering mines in northern West Virginia and the Greensburg-Irwin-Latrobe district of Pennsylvania. There is in press a technical paper on Timber Regulations in Certain Mines in Pennsylvania, Ohio, and West Virginia. Information Circular 6225, Six Essentials for Mine Roof Support has been issued. Information circulars on what the mine foreman and superintendent can do to prevent injury from falls of roof have been submitted for publication. Confidential reports with recommendations covering methods and practice for the prevention of injury from falls of roof and coal have been issued to 3 companies in Pennsylvania, covering 6 mines, 8 in West Virginia, and 4 in Ohio; and 2 special reports have been made on a group of mines in Wyoming.

Coal-mining methods and costs.—Four information circulars were issued during the year dealing with mining methods and costs of Pennsylvania and Ohio coal-mining operations.

Work in Alaska.—The activities of the Bureau of Mines in Alaska during the fiscal year were again confined to the mine-safety service, assaying and mineral analysis for prospectors and others, and the sampling and analysis of coal. The supervision of this work continued in charge of the supervising mining engineer for the Geological Survey in Alaska, with headquarters at Anchorage and branch offices at Juneau and Fairbanks.

The mine-safety work in Alaska is conducted by a senior foreman miner assigned from the bureau staff. His duties include giving to miners and subordinate mine officials training in approved mine rescue and first-aid methods; giving instruction in accident prevention, in the nature and seriousness of various types of hazards that are met in the mining industry, and approved methods of eliminating or overcoming them; conducting field contests in first-aid and mine-rescue work; giving exhibits and demonstrations of the bureau's safety work; and maintaining in condition for service the rescue apparatus provided in that Territory by the bureau.

A fully equipped mine rescue car is maintained on the Alaska Railroad for service at the operating coal mines adjacent thereto. This car also serves as a base for training in mine rescue and first aid. Oxygen breathing apparatus, an approved inhalator, and other mine rescue equipment are kept at Juneau for use at any disaster in the mines of southeastern Alaska. During 1929 mine-rescue and first-aid service was extended to the Seward Peninsula district for the first time since the beginning of this work in Alaska.

Assaying and mineral analysis was continued by the bureau at the Alaska Agricultural College and School of Mines at Fairbanks. This service provides prospectors and others with an opportunity to obtain official assays of ore samples at actual cost and to have identification tests of mineral specimens made free of charge.

The analysis of samples of coal in Alaska is carried on by the Bureau of Mines in a well-equipped laboratory at Anchorage furnished by the Alaska Railroad. All coal purchased by the Alaska Railroad under contract from private operators is inspected, sampled, and analyzed. The facilities of the coal-analysis service are also available to other departments and bureaus of the Government and to the public.

Search for domestic potash supplies.—Investigation of potash deposits, authorized by act of Congress of June 25, 1926, was actively continued during the year. Five wells were drilled in New Mexico, bringing the total number of wells completed to 17. These five wells were situated as follows: No. 13, in Eddy County; No. 14, in Lea County; No. 15, in Eddy County; No. 16, in Chaves County; and No. 17, in Lea County. Well No. 18, in Loving County, Tex., the drilling of which was started on June 5, 1930, had reached a depth of 782 feet on June 30, 1930. The total footage drilled during the year was 8,187 feet 6 inches, at a cost of $61,487.09 or $7.51 per foot.

Funds appropriated for 1930 will be sufficient for completion of well No. 18, and there will be a small balance to apply on the drilling of No. 19, contract for which was signed on June 28, 1930. Of the $100,000 appropriated for this purpose $12,500 was transferred to the Geological Survey to defray expenses of field and laboratory work in connection with selection of drilling sites and examination and analysis of core samples; $4,790.84 was expended by the Bureau of Mines for salary and expenses of the bureau engineer in charge of drilling operations, leaving $82,709.16 for actual drilling.

A report on the production, costs, and possibilities of marketing of potash salts derived from polyhalite has been issued as Bulletin 316, Commercial Possibilities of the Texas-New Mexico Potash Deposits. A bibliography of potash literature is in press.

METALLURGICAL DIVISION

The work of this division embraces studies of physical chemistry of steel making, crushing and grinding of ores, flotation fundamentals, reactions in the blast furnace, specific heats and heats of formation of oxides and sulphides, rates of reactions of various metallurgical materials, solubility studies, etc. All of these data are basic in the industries to which they apply and equally concern all those within the industry.

Utilization of low-grade manganese ores.—A major activity of the metallurgical division during the past year has been the development of methods that can be applied to the production of manganese from low-grade domestic deposits. These studies have been carried out by the nonferrous, ferrous, and ore-dressing sections of the division. The nonferrous metallurgists have studied hydrometallurgical methods, the ferrous metallurgists have worked on a pyrometallurgical process for producing manganese from manganiferous iron ores, and the ore dressers have devised mechanical methods of concentration. All have shown some progress.

The bureau has demonstrated by tests with its experimental blast furnace, a half-ton, open-hearth furnace, and a small arc-type electric furnace, that the manganese in these ores can be recovered as a high-manganese slag which constitutes an artificial ore from which standard ferromanganese can be produced. The quality of this slag has been improved greatly during the past year. The average manganese content has been increased from 47.5 to 53.5 per cent and the silica content lowered from about 15 per cent to under 10 per cent. Slag made in electric-furnace tests contained as high as 75 per cent manganous oxide. A newly developed procedure increased the recovery of manganese in the slag and shortened the time required to make a heat. The method of treatment involves standard metallurgical furnaces and refractories and can be put in operation quickly if necessary.

Some of this improvement has been made possible by thorough study of the slag system FeO-MnO-SiO_2 and certain portions of the system MnO-CaO-SiO_2-Al_2O_3. The results are also of great importance to the study of the deoxidation of steel with manganese alloys.

As part of the investigation of hydrometallurgical methods of manganese recovery studies have been made of the dissolution of various manganese minerals and methods for recovering manganese from the solutions. The rate of oxidation of different oxides of manganese, and the action of sulphur dioxide on manganese oxides at elevated temperatures, have also been investigated.

In 1929 it was reported that manganese carbonate had been successfully floated on a laboratory scale. During the past year this has been commercialized, and concentrates of ferro grade have been made.

The high-silica manganiferous iron ores of the Cuyuna district (Minnesota) have hitherto been valueless, but in a recent laboratory study merchantable concentrates have been made by both table concentration and flotation. To test the process, a pilot mill is being built at Crosby, Minn., from which concentrates of spiegel grade are expected.

Preliminary examination was given a variety of samples sent by operators from various places in the United States. Many were not amenable to beneficiation, but others gave promise of successful commercial concentration; laboratory investigation has shown that several deposits have commercial value.

FERROUS METALLURGY

Physical chemistry of steel making.—The problems connected with producing high-quality steel at low cost are being investigated by the bureau at the Pittsburgh Experiment Station, in cooperation with other agencies, including the Carnegie Institute of Technology and a metallurgical advisory board, through a program of research now in its fourth year. Studies are being carried on in small electric furnaces at the Pittsburgh Experiment Station and by bureau engineers in many of the steel plants in the Pittsburgh and other districts. The problem of clean steel is primarily one of oxidation and subsequent deoxidation of the metal, and it is around these two factors that the program has been built.

Blast-furnace problems.—Quantitative information is almost entirely lacking on many phases of the blast-furnace process, although the pig-iron industry assumes large proportions and is a comparatively old industry. The process has gradually evolved to its present state of development by empirical methods. In attempting to formulate a quantitative conception of the blast-furnace process, data have been obtained which apply to a number of the commonest industrial processes. The transfer of heat from gases to solids takes place in blast furnaces, fuel beds, limekilns, foundry cupolas, and in gas producers. Proper heat transfer is essential in other almost identical fields, such as checker-brick regenerators, packed still columns, coking processes, and sintering operations.

The bureau has obtained data which make it possible to evaluate the effect of gas compositions, heat capacity of solid charge, gas velocity, temperature, voids in the bed, and particle size upon the coefficient of heat transfer. Experimental data have been published for heat transfer from gases similar to air to iron ore, coke, limestone, bituminous coal, anthracite, and a typical blast-furnace charge.

NONFERROUS METALLURGY

Fundamental metallurgical data.—Data on the specific heats of metals, oxides, and sulphides at high and low temperatures, heats of formation, entropies, free energies, and vapor pressures are only to be found scattered here and there through the technical literature of metallurgy. The experiment station of the bureau at Berkeley, Calif., is presenting data in a form useful to the practical metallurgist, is supplying important gaps in the field of information, and is redetermining those properties now incorrectly reported.

Outstanding accomplishments in this field have been the determination of low-temperature specific heats which have been measured for some two-thirds of the metals and oxides of the periodic system, exclusive of the rare earths. A large proportion of the material available has resulted from the work of the bureau. A complete set of data upon the fifth group of the periodic system was

obtained and prepared for publication; these materials are of great importance in lead smelting.

In the field of high-temperature specific heats a new method for obtaining data suitable for metallurgical purposes was developed; this is expected to result in a marked increase in the speed with which results may be obtained and to improve their accuracy.

Work on vapor pressures of oxides has been started. Valuable results on the vapor pressures of antimony trioxide, and mixtures of the material with lead oxide, as well as a melting-point diagram of this system, were obtained and prepared for publication.

A bulletin on zinc smelting from the thermodynamic viewpoint was prepared; it furnishes a complete and authenticated picture of the chemical processes involved and should prove indispensable in probable future attempts to improve the antiquated methods in the zinc-smelting industry.

Work on the fifth group metals and oxides has resulted in a rational understanding of the processes involved in lead softening, and application of data obtained to actual softening processes is being made.

Reclaiming gold now lost in mill tailings.—Gold associated with carbon does not amalgamate with mercury. It can now be recovered by a method developed by the bureau, which includes flotation for the concentration of the refractory minerals, a special low-temperature roasting of the concentrates, and cyanidation of the calcine for almost complete recovery of the gold.

In large copper concentrating mills the value in gold per ton of ore is usually so low that its recovery has been given little consideration. The totals per year indicate a large gold loss. It is shown that recoveries are improved by careful control of the alkalinity in the flotation circuit. In one instance a recovery of 50 per cent of the gold was raised to 85 per cent, with the same copper recovery.

Utilization of low-grade domestic chromites.—An investigation has been made of the effects of various impurities and reagents on the oxidation reactions during the roasting of chromite ore to produce chromates. The application of these data to the utilization of low-grade, domestic chromite ores is now being studied. Concentration tests have been made of chromite ores from some of the more important domestic deposits.

Smelting in the lead blast furnace.—Continued study has revealed that, under some conditions of operation obtaining at commercial plants, the slags being made, including their lead content, may vary from tuyère to tuyère. The importance of the proper preparation and loading of the charge into the blast furnace, so as to secure uniformity, has been brought out in a marked way. The forms of combination of the lead being lost in the slags from several commercial blast furnaces have been determined. By knowing the forms in which the lead is lost the smelter man can judge to which of the preceding operations such a loss of lead was due. The gases issuing from the tops of some lead blast furnaces have been found to be almost as rich in carbon monoxide as the gases issuing from the top or the ordinary iron blast furnace. It has been pointed out that under some circumstances the calorific value of such gases may be profitably utilized.

The work is now being continued at another plant having a rich lead charge, as present developments in concentration indicate that such a charge will be the typical one of the future. Particular attention is being paid to methods permitting rich charges to be handled, to the losses resulting therefrom, and to the changes resulting in the blast furnace owing to increasing richness of the charge.

Microscopic investigations.—Microscopic studies during the year have continued to find the causes for mill-tailings losses where other methods of identification have failed. A procedure has been perfected for mounting extremely small mineral grains for microscopic study. A decantation method has been developed for classifying the minus 200-mesh metallic components of mill products into divisions corresponding to theoretical sieve sizes. A routine procedure was worked out for the statistical counting and interpretation of minerals in tailings and concentrates into terms of relatively accurate chemical analyses. This method was employed in making a detailed statistical study of a porphyry ore, and resulted in changes in plant operation that have greatly improved the metallurgy by a reduction of metal loss in the tailings. Microscopic studies of leached copper minerals have given data on the physical changes involved in the various time cycles employed. Two minerals, plumbojarosite and argentojarosite, generally regarded as rare, have been found abundantly enough in oxidized lead ores of certain western districts to represent an important factor in metal losses in tailings. Microscopic studies of magnetite in smelter slags, the physical constitution of copper dross, the mineralogical form of gold and silver in tailings, and the physical form of lead in fume, have supplied beneficial information.

Volatilization of impurities from zinc concentrates.—Present methods of beneficiating zinc ores do not remove the nonzinc minerals entirely. These minerals or impurities are troublesome in subsequent treatment of the zinc concentrates; in addition, some, such as lead and cadmium, are valuable if they can be separated. Roasting of the zinc concentrates is a necessary preliminary treatment for the recovery of zinc by both the retort and the electrolytic processes. Lead can be volatilized and removed quite completely by oxidizing roasting. Cadmium can be eliminated by roasting under carefully controlled conditions of temperature and ratio of carbon monoxide to carbon dioxide. A rapid and technically accurate method of chemical analysis for cadmium was worked out in connection with this problem.

Recovery of copper from converter slag.—Actual flotation tests of samples of slowly cooled converter slag have shown that a recovery of 85 to 90 per cent, with concentrates containing 30 to 35 per cent of copper, is easily possible. Slowly cooled slags have been found easier to crush in rolls than many copper ores. The removal of copper from converter slags by this process is expected to be of value to some plants by making possible a cleaner and more acid reverberatory dump slag. The ability to discard highly ferruginous converter slag that is nearly barren of copper will be of particular benefit to plants that have been compelled to flux the iron with unprofitable siliceous ores.

Solubility of copper minerals.—A study of the dissolution of the various oxidized and sulphide copper minerals in solutions of sulphuric acid and salts of ferric iron is being made to aid those leaching low-grade disseminated copper ores. During the past year the work on chalcocite, bornite, and covellite was completed. It showed that 100 per cent of the copper in bornite and chalcocite is soluble in approximately 15 and 20 days, respectively, at 35° C. in acidulated ferric sulphate. Covellite dissolves more slowly than chalcocite but more rapidly than chalcopyrite. The rate of dissolution of chalcocite and bornite is virtually independent of the size of particle from 3 to 200 mesh. The rate of dissolution of covellite increases with decreases in particle size. Dissolution of all copper minerals is accelerated by increases in temperature.

Leaching copper ores by percolation.—A study has shown that, if copper ore is wet in a revolving cylinder with approximately 5 per cent of leaching solution, the fine material and slime cohere to the coarser particles, thus preventing segregation when the ore is charged into the leaching vat. The ore can then be leached by percolation methods, and the percentage extraction of copper is equal to that of ore with all of the minus 100-mesh material removed. The new method simplifies the leaching process, as only one operation is necessary, whereas, if the slime is removed, a percolation-leaching plant is required for the sand and an agitation unit for the slime.

Removal of water-soluble copper from ores leached by percolation.—A study has been made to improve the efficiency of washing residues from the countercurrent system of leaching to salvage the water-soluble copper. It showed that if the ore was wet before charging into the leaching vat, owing to the uniform distribution of material, the soluble copper could be removed more rapidly and less wash water was required. The latter is important in some of the semiarid regions of the United States.

Chemical methods of mineralogical analysis of copper ores.—In the treatment of low-grade copper ores by leaching or flotation, it is necessary to know accurately the amount of oxidized copper and the amount of each oxidized copper mineral in the ores. A study of the chemical methods for the determination of total oxidized copper in common use by the leading copper companies has shown that none of the methods is exact because cuprite and some of the copper silicates are not completely dissolved. A method has been developed that apparently gives complete dissolution of the oxidized copper. Encouraging progress has also been made on chemical methods of determining the individual oxidized copper minerals in the presence of each other.

ORE DRESSING

Ball and rod mill grinding.—Fundamental data on the total efficiency, useful efficiency, iron wear, power input, amount of finished product, and nature of the finest material produced were obtained in ball-milling experiments in which the mill speed, the size of balls used, and the pulp density were the variable factors. The results showed that the best work was done at 72 per cent of the critical (centrifuging) speed, with balls three or four times the diameter of the largest particles and with a pulp density of 50 to 52 per cent,

based on volume. Of these three variables, pulp density had by far the greatest effect.

By using mills so short that slipping was reduced to a minimum, definite relationships were obtained between mill diameter, speed, and power. When the work was extended to mills of commercial proportions—that is, to mills long enough to allow slipping of the charge—the slipping prevented correlation of power and speed. Power depends upon slipping, and slipping depends largely upon the grain size, amount of balls, and density of the pulp. On account of this, the published formulas have been found to be invalid. However, some laws have been established, and as a result the mechanics of ball milling is better understood.

Ill effects of flotation of dissolved salts in the Tri-State mill waters and methods for their removal.—As the underground developments in the Tri-State district of Missouri, Kansas, and Oklahoma are extended, the waters become more impure and troublesome in flotation. Although the operators had blamed zinc salts for low recoveries, experimental work by the Bureau of Mines showed that ferrous sulphate was the worst offender in hindering flotation; zinc sulphate interfered primarily by retarding the oxidation of ferrous iron. The best solution of the acid-water problem is to sink deep wells to a pure-water supply.

Flotation fundamentals.—Study of the flotability of pure minerals yields valuable data which may be applied to any ore. Investigations of the flotative properties of the sulphides of pyrite, pyrrhotite, and chalcopyrite were completed during the past year. The oxides of lead and silver, plumbojarosite, and argentojarosite have been studied in the same manner. In the nonmetallic field, feldspar was separated from quartz and mica by carefully controlled conditions of grinding and flotation.

Separation of kyanite from mica and other gangue materials.—The mineral kyanite is in great demand because of its refractory properties. The melting temperature of a kyanite product is reduced by impurities; therefore, only the very pure raw material is useful. Quite pure kyanite concentrates were obtained from Wyoming kyanite ore containing quartz, feldspar, and mica by carefully controlled grinding, sizing, and tabling. Further purification by hydraulic classification of the kyanite table concentrates yielded a salable kyanite product. A valuable by-product, muscovite mica, was obtained by the table treatment of the kyanite.

Beneficiation of Mesabi iron-ore tailings.—Examination of two tailings ponds from washing plants in the Mesabi district (Minnesota) showed that natural concentration in the ponds had carried the fine sand to the far edges, leaving a deposit so enriched that, whereas the current tailings showed 25 per cent iron, the deposit was 45 per cent iron.

By laboratory tests the naturally concentrated deposits were further beneficiated by classification and tabling. The grade of concentrates was much better than is usually shipped from the district, and 85 per cent of the iron was recovered.

Beneficiation of Missouri iron ores.—Two Missouri iron ores have been examined. Heavy garnetiferous gangue prevented the production of mill concentrates from one of them by gravity methods. In

the laboratory, excellent concentrates and high recoveries were made by roasting and magnetic separation. It was necessary to grind the other ore finer than 200-mesh to liberate enough gangue to effect a clean separation by roasting and magnetic separation.

The first ore was so refractory that roasting was relatively difficult, whereas the second was naturally pervious to heat on account of the diffused gangue and was easily roasted.

When emergency requires an added production of high-grade concentrates they can be obtained by the roasting and magnetic separation of Missouri iron ores.

Beneficiation of low-grade phosphate ores.—In the land-pebble district of Florida the recovery of phosphate from the ores is effected by simple washing and screening. Losses, however, are high and probably average nearly 50 per cent of the phosphate in the ores. Studies of samples of washer rejects from the phosphate district showed that additional recovery of a commercial phosphate product could be effected by more complete screening. During the past year auxiliary equipment, as suggested by this work, has been installed in some of the plants, and an increase in the recovery of phosphate has resulted. Laboratory experiments indicated that gravity concentration might have some application to the treatment of phosphatic sands now discarded as waste. In cooperation with several operating companies, successful gravity-concentration tests were run on this material.

PETROLEUM AND NATURAL-GAS DIVISION

The petroleum and natural-gas division is organized to perform technical research on all problems relating to drilling, development, and production; the transportation of petroleum and natural gas; and the manufacture, refining, and utilization of products obtained from these natural resources and allied substances. The problems selected for study are undertaken only after consideration of the general usefulness to industry and to the public of the findings obtained. The work of the division is carried on at six points, but all of the studies now in progress have been closely coordinated.

DRILLING AND PRODUCTION

Field development.—Engineering field reports, more than 30 of which have been published in the past 11 years, are based upon detailed studies of underground conditions, which have extended through a long enough period of the producing life of the several fields to allow relationships of structure and other factors to be established, costs of drilling and production fairly well determined, and trends in production indicated.

A typical field report, Engineering Study of the Seminole Area, has recently been issued in cooperation with the State of Oklahoma.

Engineers of the bureau have now turned their attention to a study of the Oklahoma City pool, where studies are being made jointly by the petroleum experiment station at Bartlesville, in cooperation with the State of Oklahoma, and by the Dallas field office. In addition.

the Dallas office is studying fields in Louisiana and the prolific limestone formations of western Texas.

An engineering report covering the results of a study of the Salt Flat field, Texas, has been prepared. This investigation was made for the purpose of studying the subsurface conditions in a fault-line reservoir.

The study of water encroachment and remedial measures in the Roberts-Settles field, Texas, was begun at the request of the Railroad Commission of Texas, and in cooperation with engineers representing companies operating in this field. The report on this field will supplement a study of fields in western Texas where data are being collected and compiled with special reference to the controlled operations and their effect upon oil recovery and water conditions in the Yates field.

A paper entitled "Deep Sand Development in the Cotton Valley Field, Webster Parish, La.," was presented during the year, and an engineering report covering the results of the detailed study of this field has been prepared for publication.

At the completion of the Cotton Valley field report, a study of the Zwolle (La.) field was begun. This investigation was started to outline subsurface conditions, study structural features and conditions controlling the accumulation of oil in a chalk or limestone reservoir, and obtain information on development methods and production practices.

Methods of handling producing oil wells.—Data have been collected in all representative fields of the United States on the subject of handling producing oil wells. A bulletin, supplementing an earlier publication, is in final preparation; it will give detailed descriptions of methods and equipment used in the production of oil.

Air-gas-lift methods of flowing oil wells.—In connection with its studies of production methods which should help increase the recovery of oil from reservoir sands, bureau engineers are investigating air-gas-lift methods of flowing oil wells in various parts of the country. A study of the gas-lift methods used by California operators has been completed, and a bulletin has been prepared.

In its report on the Seminole area, the bureau discusses not only air-gas-lift equipment and the methods of its application to wells in that area but also the effect of the lift on the gravity of the oil and the effect on oil production. It was found that the air-gas lift was responsible for a sustained high rate of oil production. In the later stages of lift application when the daily average production of oil became low, the intermittent injection of air or gas was general. A survey of well-production records indicates that intermittent flow has increased the daily production of many wells in the Seminole area and that the rate of production decline in many other wells was arrested.

Solubility of natural gas in crude oil.—One of the basic factors in many petroleum engineering problems, including vertical flow and oil recovery, is the solubility of gas in oil. In 1926 the bureau published the results of a laboratory study on the solubility and effects of natural gas and air in crude oils. Later work, in which pressures up to and including 1,000 pounds per square inch were used, also showed the straight-line relationship. More recently it was found

that as selected gases, such as propane, approached their critical temperatures and pressures they were soluble in crude oil in all proportions.

Since the oil-gas solutions found in the virgin producing horizons contain gases ranging from dry gas to heavy vapors, it is desirable to obtain solubility data on these mixtures, as found in nature. Many wells in the Oklahoma City field, in which the oil and gas are produced from the same horizon, have initial pressures of more than 2,000 pounds per square inch. Samples have been obtained at high pressures from these wells, and the amount of gas given off by these mixtures has been measured. By proper interpretation, these data indicate the amount of gas in solution in the oil as found in the producing horizon. Preliminary tests indicate that the relationship is not represented by a straight line, but in the virgin producing horizons as a gas approaches its critical temperature and pressure it becomes more soluble in the crude oil. Samples are also being obtained from wells in California and other producing areas. As soon as the data are analyzed, a report will be published.

Increasing the recovery from oil sands.—The oil-recovery laboratory at the bureau's petroleum experiment station, Bartlesville, Okla., continued its study of the fundamental principles and relationships involved in the various methods of increasing the recovery of oil from depleted fields. This work includes tests under controlled conditions to determine merits of the different methods of operation and repressuring media. The experimental data do not afford a quantatativs analysis in so far as field operations are concerned, but they do give some idea concerning the effect of the physical properties of the gases, when used as repressuring media in the recovery of oil. Furthermore, the comparative results brought out by the laboratory experiments should hold true to a certain extent in the field, and should aid the development of new methods by which a larger proportion of the oil left underground by ordinary oil-field operations may be profitably recovered.

The series of flow-tube experiments started two years ago was brought to completion, results derived from a number of the previous runs being confirmed. In this series of runs, propane, air, dry natural gas, a mixture of dry gas and propane, and helium were used. Helium, because it is almost insoluble in oil and has a specific gravity much less than air, was used in an effort to verify certain relationships indicated by the other media.

The data obtained from this series of gas-drive experiments have been compiled. Some of the results were given in a paper, Recent Studies on the Recovery of Oil from Sands, and a report, Recovery of Oil from Sands by the Gas Drive, will soon be published.

Another study in the oil-recovery laboratory deals with the flow of oil and gas through sands. Special attention is being paid to the effects of pressure, temperature, and the dissolved gases. As was to be expected, the preliminary experiments with gas flow through sands show a certain amount of slippage along the walls of the flow tubes, and this increases in importance with an increase in size of sand grains.

The same apparatus, under the same conditions, will be used in the study of the flow of oil through sands. As part of this investi-

gation, a study is being made of methods to determine capillarity, viscosity, and specific gravity of oil under high pressures.

Where air is used as a repressuring medium, the operator is confronted with the possible effect of oxygen in the air in causing chemical and physical changes in crude oil, which may make the removal of the oil from the sand more difficult or decrease the commercial value of the oil.

To help in solving these problems, the oil-recovery laboratory at Bartlesville has been engaged for more than a year in a study of the effect on crude petroleum of the use of air in repressuring oil fields. Tests are now being made with oxygen to accelerate possible reactions and obtain additional data.

Field studies of repressuring methods were made in the fields of Salt Creek, Wyo., Burbank, Okla., and north central Texas. Although the methods used in the different fields vary according to local conditions, repressuring has been found successful in every installation studied. On some properties, a definite increase in oil production is noted; on others, oil production stays almost constant, whereas without the use of gas it would probably have decreased.

A detailed report on the Williams pool, Callahan County, Tex., was completed. This study was made primarily to determine the effect on production of repressuring with air a lenticular sand body of low initial production, which originally contained little gas and in which the gas-oil ratio always had been relatively low.

The Williams pool, with 61 producing wells and 9 input-pressure wells, showed an estimated gain in production, over what would have been expected from normal production, of 33 per cent under repressuring methods during 1927, 78 per cent in 1928, and 76 per cent in 1929. The average initial daily production of wells in this pool was 12 barrels. The estimated net increase for the field over the 3½-year period was found to be 57,500 barrels, or 44 per cent.

Other field studies, relating to gas injection and underground gas storage, are in progress in California and the Appalachian fields.

Paraffin deposits in oil wells.—A bulletin on paraffin problems and the related problems of congealing oil has been completed. During the last year the work has been directed to determining the action upon paraffin of various solvents derived from crude oil with and without natural gas in solution.

Disposal of oil-field waters.—The purpose of this investigation is to determine an economic method for the disposal of saline oil-field waters, with special attention to the possibilities of obtaining certain salts in such quantities as to convert a present waste into an economic asset. Work was continued on the study of rare elements in oil-field brines, also on methods for determining sodium and potassium in brines. Some work was done on the determination of iodine and bromine.

Evaporation losses of petroleum and gasoline.—Studies of the evaporation losses of petroleum and gasoline have been carried on for several years by bureau engineers. Types of tank roofs, developed for the purpose of reducing evaporation losses of oil in storage, have been studied and a report, A Diaphragm or Breather Roof for Oil Storage Tanks, has been published.

A series of observations on bulk storage tanks is in progress. A group of five all-steel welded tanks, painted various colors and equipped with pressure-relief and vacuum-relief valves, will be under study for about three months, during the hottest part of the year when evaporation is greatest.

Tank corrosion.—This work was undertaken as a cooperative study to determine means of reducing the corrosion of tanks used for handling sulphur-bearing oils. With the development of fields in which high-sulphur petroleums and hydrogen sulphide-bearing gases are produced the problem became acute; several millions of dollars are lost annually in tank replacements. Of equal importance, corrosion often takes place to such an extent that vapor-tight tanks leak and become ineffective, causing a hazard to human life because of the toxicity of the hydrogen sulphide gas and permitting the escape of valuable light fractions of the oil.

The tank battery upon which observations were made was about 2 miles north of Borger, Tex. The battery consisted of one 500-barrel all-aluminum flow tank, two 250-barrel all-aluminum stock tanks, and two 250-barrel all-steel stock tanks. A field laboratory for making water analyses, photomicrographs, gas analyses, and various sulphur determinations in water, oil, and gas was established. Each tank was equipped with thermocouples and with mercury-actuated recording thermometers. Complete records were kept of the actual operating conditions in each tank. Humidity determinations were made on the vapors in each tank.

Corrosion of aluminum tanks was found to be due to the action of oil-field brines, to iron sulphide, and to electrolysis. Steel tanks were affected by hydrogen sulphide.

Transportation of gasoline by pipe line.—A study has been made and a report prepared by engineers of the San Francisco field office on the transportation of gasoline by pipe line. Until recently it was generally thought that trunk lines would not be feasible for gasoline transportation over long distances. The result of the study indicates that such transportation is practicable.

NATURAL GAS

Flow of natural gas through pipe lines.—A study of the flow of natural gas through pipe lines has been in progress for several years, in cooperation with the helium division of the Bureau of Mines and the natural-gas department of the American Gas Association. This study involves the economical handling and transportation of gas from wells to points of utilization. The design and construction of pipe lines, development of new flow formulas, and the measurement of natural gas by orifice meters, including the determination of more accurate orifice-meter coefficients and other relations, are under study.

The field investigations of pipe-line flow were completed during the year. Pipe lines were tested in Montana, Wyoming, and Texas, and many data obtained to augment the information regarding conditions of lines and methods of testing previously given in a report entitled "Flow of Natural Gas Through High-Pressure Transmission Lines." A special test of an experimental line was made to learn the possible effects of the so-called telescopic design of gas-transmis-

sion systems. The results indicate that under test conditions there was a slight advantage when gas was flowing from smaller to larger diameter pipe. Tests were made also to determine whether or not actual deliveries from telescopic lines are appreciably higher than might be expected from the substitution of values in Weymouth's formula.

The flow of gases through small orifices under high differential pressures has been investigated and the results prepared for publication as a technical paper. Work was continued in the laboratory on the compressibility of natural gas.

Methods for gaging and controlling natural-gas wells.—The method in common use for determining the capacity of a natural-gas well is responsible for a large wastage of gas, and frequently serious damage to the producing capacity of a well results from the employment of this method. A method of determining the potential capacity of a well without allowing it to blow gas to the atmosphere would be of great economic value. Accordingly, a study of the fundamental relations involved in the flow of gas through sands and the relationships between gas flow and well capacity was started. The study also pertains to methods of controlling deliveries from gas wells under back-pressure control.

Since the basis of this work is gas flow through sand, the applications will be more far-reaching than merely gaging gas-well capacities. The problems of estimated gas reserves, storage of gas in depleted sands, the use of gas as an expulsive force in oil recovery, and other operating problems are all related.

During the year, a paper entitled "The Study of Natural-Gas Fields" was published, and a third report, companion to the two previously published on the fundamental study of gas-well flow, is in preparation.

Gas-well siphons.—The removal of water from gas wells is one of the most serious problems in the production of natural gas, especially in old fields. Many districts depend for their supply of gas upon wells that produce only small volumes, and frequently as the gas supply declines the volume of water increases. The Bureau of Mines determined that, where applicable, the cheapest and best method for removing water from gas wells is by means of siphons. A report has been published describing the design and operation of gas-well siphons.

CHEMISTRY AND REFINING OF PETROLEUM

Study of crude petroleum.—The value of fundamental information concerning different crude oils, as a source of material for the manufacture of various commercial products, is well recognized. Pursuant to this need, a paper has been completed giving the results of a study of Cabin Creek (W. Va.) crude. Work has been continued on a refining study of Tonkawa (Okla.) and Midway (Calif.) crude petroleums, and additional data were compiled for a bulletin on the Chemistry of Crude Petroleum as Shown by Hempel Analysis.

The survey of crude oils produced in various fields was extended, with typical samples obtained from deep producing zones of the Gulf coast, Pennsylvania, California, and the Mid-Continent. Rep-

resentative samples from the principal sands of the Seminole area were analyzed and the results published. Similar analyses are being made of Oklahoma City pool crude and oils from other areas where field studies are in progress.

A companion report to the bureau's publication, Properties of Typical Crude Oils from the Producing Fields of the Western Hemisphere, is being written. More than 150 samples have been obtained from fields in the Eastern Hemisphere. The results of this study will make it possible to compare the properties of oils, about which little has been known heretofore, with similar oils produced in the United States.

Separation of wax from wax distillates.—A study of refining of wax has been made to develop methods of handling wax distillates in order that the bad effects of amorphous wax might be minimized. Large quantities of crude oil would thus be made available for the manufacture of high-grade lubricating oil.

Sulphur compounds in crude oil.—The present major refinery study of the bureau deals with sulphur in crude oils and refined products. This problem is of national importance, both from a technologic and economic viewpoint. Fundamental research on the isolation and identification of the various sulphur compounds occurring in crude petroleum must be considered in relation to the manufacturing problems. The problem is not complete without cognizance of the relations of high sulphur-bearing oils to the whole economic structure of the petroleum industry. A manuscript, giving the results of one study on this subject, entitled "The Effect of Careful Fractionation on the Sulphur Compounds in Crude Petroleum," has been completed.

Treatment of light-petroleum distillates.—A detailed study has been made of commercial methods for treating light distillates at refineries throughout the United States, in order to determine some of the objectionable constituents present in gasoline, pressure distillate, kerosene, and other light-petroleum products, and to ascertain what methods may be best applied to remove them. These studies show that scant attention is paid to the fact that the major portion of the undesirable compounds in motor fuel usually occurs within a comparatively narrow boiling range.

Removal of asphalt and sulphur compounds from California lubricating crudes by fractional distillation.—A refinery study at the San Francisco field office, which correlates closely with the studies of sulphur in petroleum now in progress at the petroleum experiment station, has been directed to methods of removing asphalt and sulphur compounds from California crudes by fractional distillation. If these methods can be proved feasible, an added amount of oil having highly valuable lubricating constituents can be conserved. A large experimental vacuum still operating under high vacuum has been constructed, and the study indicates that this method for removing asphalt and sulphur compounds will be entirely feasible.

Refining of black oils of the Rocky Mountains.—A study of the so-called black oils of the Rocky Mountain region, particularly those of Wyoming, was started by engineers at the Laramie (Wyo.) petroleum field office. This problem was actively undertaken only after a careful preliminary survey of economic conditions in their relation

to oil conservation had been made by the Bureau of Mines. A laboratory and refinery study is being made to develop a wider range of uses for this oil. A field study also is being made of the potential resources of this crude.

Motor-gasoline surveys.—To determine the quality of gasoline marketed in the United States and its relation to refining problems the semiannual motor-gasoline surveys were continued. Gasoline samples collected from various cities representative of the important marketing territories in the United States were tested in accordance with the methods described in detail in Bureau of Mines Technical Paper 323B. The results are given in the twentieth and twenty-first semiannual motor-gasoline surveys.

It is planned to increase the scope of future surveys by increasing the number of periodic samples to 300. Determinations will be made for distillation range, Reid vapor pressure, gum content (two methods), copper-strip corrosion, sulphur content, color, doctor test, and gravity.

During the past several years a great deal of discussion has centered around the question of the permissible limit of sulphur content in fuels for automotive and aviation motors. Data gathered in connection with the twenty-first semiannual motor-gasoline survey indicate that the reduction of sulphur content of motor fuel is a problem to a relatively small number of refiners and of little or no concern to the remainder; in fact, more than 90 per cent of the 153 samples analyzed passed the Federal specification requirement, which limits the sulphur content to 0.10 per cent.

Synthesis of hydrocarbon motor fuels.—To develop a possible use for natural gas now wasted the synthesis of hydrocarbon motor fuels from natural gas (mainly methane) by means of heat, pressure, and other agencies is being studied.

The aromatic hydrocarbons, especially benzol, are well known antiknock automotive fuels; and their manufacture from natural gas, especially from gas composed chiefly of methane, would provide a profitable use for much gas at present not utilized. To determine the optimum conditions for this transformation of gas to liquid fuel decomposition of methane is being studied.

The experimental work on this problem consists of cracking or thermal decomposition of the methane, whereby its decomposition products are polymerized to hydrocarbons of more complex nature, and of experimental development of analytical methods, especially for gas and very volatile liquids.

Gas samples from Poteau, Okla., proved to be very well suited to the needs of the work, as they contain about 97 per cent of methane and no higher hydrocarbons.

OIL SHALE

The research problems initiated last year for the cracking and refining of shale oil have been continued. By previous experiments 65 per cent of the crude oil was converted into crude pressure distillate, of which 83 per cent was made into finished gasoline. During the past year a study was made of the total sulphur and nitrogen in the crude oils produced a year ago at the experimental oil-shale

plant at Rulison, Colo., and in the pressure distillate and coke made from the crudes. A saving of chemicals used in refining pressure distillates was effected; a few of the nitrogen compounds were identified and found to be recoverable for use; experiments were made to increase the unsaturation in the refined motor fuel; the compressive strength of the rich and lean shale strata at the experimental mine of the Bureau of Mines in Colorado on naval oil shale reserve No. 1 was determined; and a comparative horsepower test between a standard petroleum gasoline and shale-oil gasoline was made.

A bulletin giving the complete results of the work at the experimental oil-shale plant at Rulison, Colo., and at the oil-shale laboratory and experimental refinery at Boulder, Colo., in 1925–1927, was published during this year. A second bulletin, which will describe the work in 1928 and 1929, is being prepared.

SAFETY IN THE PETROLEUM INDUSTRY

The safety work of the bureau in the Mid-Continent field has developed a better understanding of the need for systematic studies of the causes of accidents and suitable methods of preventing them by showing the economic aspect of such accidents.

As a first step in this general program, promotion of first-aid instruction has been found necessary. During the past several years, Bureau of Mines first-aid trainers have visited the Mid-Continent district and have trained employees of many petroleum-producing and refining companies. Most of these companies now have well-trained first-aid and rescue teams that study these subjects intensively and take part in first-aid competitions. During the past year the work in first aid has been carried on actively.

BIBLIOGRAPHY OF PETROLEUM AND ALLIED SUBSTANCES

Monthly bibliographies of recent articles relative to the petroleum and natural-gas industry were compiled and published by the San Francisco petroleum field office in cooperation with the American Petroleum Institute and the Special Libraries Association. The cooperation of these organizations will make it possible to cover completely all literature published in the world on this subject and to bring the abstracts of the articles to the attention of the industry in a minimum of time.

EXPERIMENT STATIONS DIVISION

The experiment stations division has administrative control and coordinates the work of the 11 experiment stations at which the technologic studies of the bureau are mainly conducted. In addition, the chief engineer of the division has technical supervision over the bureau's research work on nonmetallic minerals, coal preparation, and coal chemistry. The problems being studied at the various experiment stations are outlined in this report under the technical divisions supervising the work described.

Work of the different stations.—The Pittsburgh Experiment Station, at Pittsburgh, Pa., is by far the largest of the 11 stations and chiefly handles problems relating to coal mining, the utilization of

coal and coal products, the health of workers in the mineral and allied industries, the technology and safety of explosives and electrical mine equipment, and the metallurgy of iron and steel. This station has supervision over the experimental mine at Bruceton, Pa., 14 miles away, which is operated exclusively for the purpose of scientific research.

The Petroleum Experiment Station, at Bartlesville, Okla., is the largest research plant in the world exclusively devoted to the study of problems affecting the production and refining of petroleum and the utilization and conservation of petroleum and natural gas.

The Southern Experiment Station, at Tuscaloosa, Ala., gives particular attention to the problems of the coal, iron, and nonmetallic industries of the Southern States.

The Nonmetallic Minerals Experiment Station, at New Brunswick, N. J., conducts inquiries into the treatment and use of numerous important nonmetallic mineral products. At present efforts are being concentrated on the development of methods for the utilization of polyhalite, greensand, leucite, alunite, etc., as sources of potash.

The North Central Experiment Station, at Minneapolis, Minn., works on problems connected with the beneficiation and smelting of manganiferous iron ores of the Lake Superior region and with the study of fundamental blast-furnace reactions.

The Mississippi Valley Experiment Station, at Rolla, Mo., seeks to prevent waste and to increase efficiency in the important lead and zinc industries of the Mississippi Valley. It is also a center for the bureau's ore-dressing studies.

The Intermountain Experiment Station, at Salt Lake City, Utah, studies the treatment of the complex low-grade ores, the development of which affects the progress of the region. The station gives attention to the study of the flotation process in metallurgy.

The Northwest Experiment Station, at Seattle, Wash., investigates the mining problems and the utilization of the coals and nonmetallic minerals of the Pacific Northwest and Alaska.

The Pacific Experiment Station, at Berkeley, Calif., conducts highly specialized research concerned chiefly with the determination of metallurgical constants.

The Rare and Precious Metals Experiment Station, at Reno, Nev., carries on research as to more efficient production of rare and precious metals, including the utilization of low-grade ores not now commercially of value.

The Southwest Experiment Station, at Tucson, Ariz., is concerned with the mining and metallurgical problems of the Southwest, especially those affecting the mining and treatment of low-grade copper ores.

NONMETALLIC MINERALS

Extraction of potash from its minerals.—The drilling program of the bureau in Texas and New Mexico has shown the existence of extensive beds of polyhalite, a complex hydrous potassium-magnesium-calcium sulphate. Research in the past year by the Nonmetallic Minerals Experiment Station has led to the development on a laboratory scale of two processes of possible industrial importance for the extraction of the potash from this salt. One produces potas-

sium sulphate and the other makes both potassium sulphate and a double salt containing magnesium and potassium sulphates. Preliminary estimates show that the average cost of producing 90 per cent potassium sulphate by either process will be $16 per ton at the plant and of producing double sulphate of potash magnesia, $9 per ton at the plant. If a reasonable freight rate to seaboard can be obtained, potash from Texas polyhalite probably can compete successfully with imported products.

These two processes are discussed in detail in Bulletin 316, Commercial Possibilities of Texas-New Mexico Potash Deposits. The physical chemistry of these processes and others for the extraction of potash from polyhalite is described in Report of Investigations 3002, A Study of the Properties of Texas Polyhalite Pertaining to the Extraction of Potash.

Preliminary data have been obtained concerning the following processes:

1. The production of muriate of potash by treatment of polyhalite with saturated salt solutions and subsequent evaporation of the leach liquors.

2. The production of syngenite (a double salt of potassium and calcium sulphate) by the reaction between dilute potassium sulphate solutions and calcined polyhalite.

3. The production of potassium sulphate and magnesium oxide by treating the liquors, obtained by the extraction of calcined polyhalite with water, with slaked lime slurry, and the separation into its constituents of the mixture of magnesia and gypsum thus obtained.

4. The production of potassium chloride and magnesium oxide by treatment with calcium chloride of the leach liquors obtained from the extraction of calcined polyhalite with saturated salt solutions, the mother liquor being subsequently treated with slaked-lime slurry to precipitate magnesia.

The data obtained show that the use of finely ground polyhalite as a fertilizer is possible, the rate of decomposition by water being rapid enough to dissolve all of the potash in a few days, assuming a temperate climate where a ratio of 6 parts of water to 1 of polyhalite is feasible.

Utilization of nonmetallic minerals in metallurgical processes.—One time-consuming factor in research work on high-temperature metallurgical processes (such as the manufacture of pig iron and copper) is the manufacture of superrefractory crucibles in which the experiments can be conducted. Because of the very great chemical activity of slags at 1,500° to 1,800° C. the crucibles are formed from relatively inert nonplastic materials such as pure periclase (fused magnesium oxide). Owing to the lack of plasticity of these materials, either hydraulic pressure or the pressure developed by mechanical impacts of a hammer or mallet on the refractory paste contained in a mold must be used. The impact method is laborious and lengthy. There have been two serious obstacles to the hydraulic-pressure method, the difficulty of removing the crucible from the mold and the development of fine cracks on drying or on firing the crucible. Experiments at the Nonmetallic Minerals Experiment Station during the past year have, to a large extent, eliminated these two difficulties. The use of a dilute hydrochloric acid solution instead of water to

moisten the refractory before packing into the mold (of steel) has been found to result in clean separation of the formed crucible from the mold.

The cracking upon drying and firing has been found to be mainly due to two causes, the difficulty of providing equal pressure upon the sides and walls of the crucible while forming it, and the nonuniform expansion of even a perfectly formed crucible upon drying and firing. The latter has been almost completely counteracted by the use of small amounts of boric or phosphoric acids in the refractory mix.

Fundamental factors involved in the utilization of anhydrite in cement retardation.—To determine the effect of the degree of fineness of the retarder and of the clinker on the time of set and other physical characteristics of Portland cement an air analyzer for separating fine powders into closely sized fractions such as 0 to 5 micron, 5 to 10 micron particles, etc., has been designed. Anhydrite powder of mean particle size 1.96 and 3.17 microns (1 micron=1/25,000 inch) dissolved at such a rate that the saturation solubility of gypsum was reached within 7 minutes and then surpassed to a maximum of 0.298 grams per 100 cubic centimeters. If the rate of solution of the retarder is a factor in the set of cement, as seems probable, it would seem permissible to utilize gypsum containing a large percentage of anhydrite, provided this retarder is ground finely enough.

Ochers and mineral pigments of the United States.—Preliminary tests of 198 samples of possible ochers and mineral pigments of yellow, brown, red, and black colors from 23 States and the Philippine Islands have been made for color, oil absorption, and color strength in comparison with 48 commercial mineral pigments. The results indicate that a large number have commercial possibilities if the economic phases of mining, preparation, and transportation are satisfactory. It is hoped that some of the yellow ochers may be as satisfactory to the trade as the French ochers now considered standard in color-pigment markets.

Dewatering of clays by electrophoresis.—The electrical method for dewatering clays is being thoroughly tested because it can be made continuous, with lower labor costs than other methods. Results show that (1) the electrophoresis process removes the clay from the water, but does not effect any appreciable purification of the clay; (2) the degree of dryness obtainable with a given clay and the count of electrolyte and electric current necesary for this are, to a large extent, individually characteristic of the clay in question; and (3) if the temperature of the suspension is allowed to rise above a certain maximum, approximately 40° C., the efficiency of the process is decreased, owing to the increased conductivity.

Kaolins of the Pacific Northwest.—An intermittent series of studies of the kaolins and white-ware materials of the Pacific Northwest has been under way for some years at the bureau's northwest experiment station. These materials from eastern Washington and northwestern Idaho are now used without purification for light-colored structural products and fire brick. In recent years emphasis has been placed on methods of purification, the development of laboratory clay-washing apparatus, and studies of dewatering by spray evaporators and electrical methods.

COAL PREPARATION

Coal washing in Alabama.—There are more coal-washing plants in Alabama than in any other State, and the quality of the coal produced as well as the extent of the loss of coal in the refuse depends largely on efficiency of operation. Experiments by the Bureau of Mines at some of the plants have shown ways of reducing the ash in the washed coal by several per cent without increasing the loss of coal in the refuse. Washability studies have been made of run-of-mine coal from the Mary Lee and Black Creek beds in the Warrior field. The results show the grade of washed coal to be expected and the percentage of washed coal that should be obtained from the run-of-mine product with a properly operated washing plant. This sets a standard toward which the operators can work and provides a means for checking the performance of plants now in operation.

Performance of pneumatic coal-cleaning table.—A laboratory study has been made of the performance of a full-size pneumatic coal-cleaning table of a type now in use in coal-cleaning plants, with the object of ascertaining the mechanism of the separation of coal and impurity. The results of this investigation show that (1) for best results in single-pass treatment the feed should be sized at least in a 2 to 1 ratio, (2) the sizing action of the table is the reverse of the wet coal-washing table in that the finest sizes in the feed are discharged in the first zones and the coarsest particles in the last zones, and (3) the efficiency of separation for a feed of given size decreases with decreasing particle size.

Effect of particle shape on concentration.—In addition to size and specific gravity, shape of the particles or grains, in the feed to a mineral concentrating machine is also a determining factor in concentration; the exact influence of shape is difficult to evaluate because no adequate means have been available for measuring shape quantitatively. Accordingly the bureau has adopted a screen scale consisting of square and rectangular hole screens for estimating the shape of particles in the feed or any of the products of concentrating machines. Application of this method to a study of coal beneficiation with two types of equipment, the wet table and the pneumatic table, has been completed. The results showed that shape of particle was not of great importance in affecting the efficiency of separation of coal and impurity on the wet table but is of primary importance on the pneumatic table.

EXPLOSIVES DIVISION

Operators of metal mines, quarries, and engineering operations in which explosives are employed look to the bureau for authoritative information on the explosives they use. In the course of many investigations of the characteristics and behavior of explosives and the phenomena accompanying explosions, incidental information of importance to these industries has been acquired and published. It is highly important that at an early date the means may be provided for giving equal consideration to the needs of all branches of mining for scientific information on the characteristics and uses of explosives.

Active list of permissible explosives and blasting devices.—Monthly lists are published of the explosives and blasting devices that have passed the bureau's tests for permissibility, and at the end of each fiscal year a complete list of all active permissible explosives and blasting devices is issued. On June 30, 1930, there were 127 permissible explosives and 3 permissible blasting devices on these lists.

Field samples of permissible explosives.—Explosives which have been placed on the permissible list have passed gallery tests in gas and coal dust which simulate the severe conditions under which explosives may be used in coal mines; a friction test to determine whether the explosive is unduly sensitive to the shocks and friction to which it may be subjected in use; and efficiency tests which measure its strength.

To insure maintenance of the quality of these explosives, samples of permissible explosives are obtained by the engineers of the bureau from users' magazines and tested to determine how closely they conform to the samples upon which the permissibility tests were originally made. Chemical and physical items which exceed prescribed tolerances are brought to the attention of the manufacturer in order that he may apply a remedy. A particular lot of a permissible explosive is declared nonpermissible if it fails to pass any of the safety tests. Both the manufacturer and user are notified of the results of the safety tests of field samples.

Permissible blasting devices.—The permissible blasting devices are tested under the conditions and requirements of Schedule 20, which includes all devices for breaking down coal except those where the operation is wholly mechanical and obviously does not present any explosive hazard. Three new blasting devices, which have been tested and approved, utilize liquid carbon dioxide as a blasting agent. This agent is confined in a stout steel cylinder, with a heater element centrally disposed in the shell. Combustion of this heater element supplies sufficient heat to gasify the carbon dioxide. One end of the steel cylinder is hermetically closed by a replaceable steel disk. The heater element is fired electrically with a permissible blasting unit, in much the same manner as charges of explosives are fired. The heat produced when the heater element is fired gasifies the carbon dioxide, thereby producing enough pressure to shear the steel disk. The force exerted by the released gas brings down the coal.

Blasting tests with Cardox.—The permissible blasting devices (Cardox) are being tested in blasting coal at a mine near Pittsburgh, Pa., to determine the safety and efficiency of these devices under actual mining conditions, with special reference to the combination of disk, heater, and carbon-dioxide charge that may be most efficient and economical in bringing down the maximum coal per shot. This charge may not necessarily be the most efficient in producing the maximum quantity of lump coal; hence screening tests will be made of the blasted coal in order to secure data on the proportion of lump coal produced.

Fumes produced in blasting.—Field tests have been completed in cooperation with one of the large powder companies on a series of specially prepared gelatin dynamites. The effects of composition of dynamite and method of loading on quantity and character of the

fumes produced have been investigated. Toxic gases are mainly carbon monoxide and oxides of nitrogen. The amount of carbon monoxide is a function of the oxygen balance, but the production of oxides of nitrogen depends largely on the loading conditions. For example, wet boreholes have been found to give off large amounts of oxides of nitrogen when the blast is fired. Work is in progress to develop a laboratory apparatus which will make possible prediction of the field performance of an explosive from the standpoint of fume production.

Propulsive strength of dynamites.—As part of an investigation of the factors influencing the effectiveness of dynamites in actual blasting, the strength of dynamites has been determined by various methods. In one type of device, known as the Trauzl lead block, a charge of dynamite is fired inside of a cylindrical block of lead and the volume of the resultant expanding chamber is taken as a measure of the strength of the explosives. The variables affecting Trauzl lead-block tests are purity of lead, temperature at time of test, grade of detonator, oxygen balance and explosive, and effect of tin foil in which the explosive is wrapped. Strength tests have been made of a variety of types and grades of dynamites and the results compared with those obtained with the ballistic pendulum. In general, results with these two types of testing devices agree closely.

Flame-quenching substances.—With a view to reducing the inflammability of methane, the chief constituent of mine gas, a number of extinctive gases and vapors are being investigated. The extinctive effect on methane of carbon dioxide, carbon tetrachloride, and nitrogen has been determined carefully, and recently experiments have been made with the new refrigerant dichloro-difluoro-methane. This substance, which is less toxic than carbon monoxide, is a gas at room temperature and pressure. Its extinctive effect is almost identical with that of carbon tetrachloride on a volumetric basis and is superior to that of such gases as carbon dioxide, helium, nitrogen, and argon.

Photography of shock waves.—A study of the ignition of explosive gas mixtures in coal mines has shown that invisible pressure waves play a part in propagating the explosion. Payman's wave-speed camera is being employed in a study of the rôle played by these shock waves in the ignition by explosives of inflammable methane-air mixtures.

HELIUM DIVISION

Helium, an inert gas, and, next to hydrogen, the lightest substance known, is obtained in quantities sufficient for aeronautic use only in certain natural gases of the United States, where it was found late in 1905. Its safety and lifting power having been demonstrated by the Bureau of Mines during the World War, its importance to aeronautics has been growing rapidly, particularly in view of the Government program for constructing mammoth dirigibles each requiring 6,500,000 cubic feet of the gas to lift it.

Through the work of the Bureau of Mines as much as 24,000,000 cubic feet a year is now available for Government use, at a cost of considerably less than 1 cent per cubic foot.

The production of helium for aeronautic use was first attempted through cooperation of the Government with commercial concerns,

under Bureau of Mines supervision, in three experimental plants erected during the war. After the armistice these plants were closed.

The process developed in one of them was later adopted for use in a large production plant erected near Fort Worth, Tex. This plant came under the jurisdiction of the Bureau of Mines on July 1, 1925, but it, too, was abandoned owing to depletion of the Petrolia gas field supplying its raw material. The Petrolia field was old when the Government's helium project started, but was at that time the best-known source of a large-scale helium-bearing gas supply. Meanwhile the bureau had been conducting an intensive survey for new supplies of the gas and discovered a great resource of helium-bearing gas in the Cliffside structure of the Amarillo field, Potter County, Tex., having a helium content of 1¾ per cent. As early as the first part of 1926, with the supply of gas for the Fort Worth plant rapidly failing, work was begun toward acquisition of the gas reserves of the Cliffside structure and erection of a plant near Amarillo. In 1927 an operating contract and option covering 20,000 acres of land on the Cliffside structure was entered into by the Department of Commerce. This was followed by exercise of the option and other contracts and purchases giving the Government control of the gas in about 50,000 acres of land. The reserve of gas in the structure, and the Government's control over it, assure the Army and Navy an adequate supply of helium for many years.

The Amarillo plant, designed and constructed by helium division engineers for two units, with possibility of expansion to three, is on a Government-owned site at Soncy, 7 miles west of Amarillo. The first unit was placed in production in April, 1929; the second unit was completed in May, 1930. Four gas wells have been drilled on the Cliffside structure. A pipe line, with gathering lines and appurtenances, was constructed from the wells to the plant, about 11 miles distant; and a line to convey processed or residue gas was laid from the plant to points of commercial consumption at Amarillo. The first shipment of helium from this plant was made to the Army at Langley Field, Va., May 6, 1929.

Helium production.—Helium production was carried on during this fiscal year exclusively at the United States Bureau of Mines Amarillo helium plant at Soncy. Dismantling and the disposal of the equipment of the production plant at Fort Worth were begun in 1929 and completed in 1930.

The plant at Soncy produced almost 10,000,000 cubic feet of helium during the fiscal year 1930, approximately three-fourths for Navy account and one-fourth for Army account. For two months of the year, December and February, however, the plant was idle, being kept in a stand-by condition through lack of orders for helium. Only one unit was in operation up to May 4, when the second unit was completed and tied into the production line. The efficiency of the first unit was greatly increased during the year through modifications in operating practice and increased operating skill developed by the crew. The second unit, fabricated and erected by the staff of the helium division at the plant, has proved highly satisfactory. This plant, operating the two units on gas from the Cliffside structure at Amarillo, will produce, without trou-

ble, 2,000,000 cubic feet or more of helium per month. The airship gas produced by the Amarillo plant is about 98 per cent helium, whereas 96 per cent was considered to be high purity at the former Fort Worth plant. Costs for each month's operation are computed on the basis of the cubic feet of the helium element contained in the plant's output of airship gas. Continued improvement in efficiency and capacity, as the year advanced, has resulted in a steady lowering of net costs of production from $17.25 per thousand cubic feet of contained helium in July, 1929, to $6.22 per thousand cubic feet in June, 1930. These are, collectively, the best results ever attained in helium production. Helium was never before produced so cheaply or at such a high rate of output. Additional lowering of costs is anticipated as production is increased to meet greater demands.

Permanent high-pressure storage equipment has been constructed at the plant, with a capacity of 3,000,000 cubic feet of helium, under 1,800 pounds pressure, by manifolding together multiple units of approximately 18,000 surplus steel cylinders of standard size.

Cryogenic laboratory.—Removal of the cryogenic laboratory from Pittsburgh to Amarillo was completed during the first part of the year. This laboratory was established originally for developing experimental data on the properties, interrelations, and reactions of gases, particularly the constituents of natural gas under low temperatures and high pressures, with special reference to helium production and purification. Its activity was later expanded to include laboratory-scale practical tests and demonstrations of designs for improving methods already in use for helium production and purification, and of such designs as might be evolved from time to time; to analyze samples of natural gas, for helium and other constituents; and to carry out all necessary plant-control analytical work.

Research on separation of hydrocarbon constituents of natural gas by improved methods, including fractional distillation at low temperatures, was carried out, and investigations were conducted on the removal of gasoline from natural gas as a prerequisite to helium production. Waste recoveries in the process of removing carbon dioxide from the raw gas coming to the plant, before processing for helium, were given attention. If not removed, carbon dioxide will freeze at the low temperatures inherent in the process and plug up the production cycle.

Natural-gas supply.—During this year contracts were executed providing for purchase by the Government of (1) the lessors' retained gas rights (royalty, etc.) in about 16,700 acres on the Cliffside structure, in which gas-leasehold rights were acquired by the Government during the fiscal year 1929; and (2) gas rights in fee in about 11,500 acres of additional land. These acquired rights pertain to the 50,000 acres of Government-controlled area already mentioned. The survey for new sources of helium-bearing natural gas was continued.

OFFICE OF THE CHIEF MINING ENGINEER

The office of the chief mining engineer has four functions: (1) Investigations at the experimental mine; (2) chairmanship of the bureau's mine-safety board: (3) cooperation with the British Government in mine-safety research; and (4) special studies.

Mine-safety board.—During the year an information circular covering 13 decisions was approved for publication. The approved decisions form the basis of teaching or policy of the bureau and relate especially to those questions on which there are differences of opinion. The board has continued a study of explosion-disaster reports, and has been called upon to make recommendations concerning schedules of test for permissibility of materials, devices, and machinery used in gassy and dusty mines.

British cooperation.—The British investigator detailed to the Pittsburgh Experiment Station continued studies in the Schlieren method of photography of explosives for the determination of fundamental factors of flame and shock-wave effects in ignition of gases. The Bureau of Mines investigator detailed to the British experimental station at Buxton, England, assisted in starting testing in the underground gallery at Buxton completed during the fiscal year.

Rock dusting in mines.—This method of preventing coal-dust explosions in mines, advocated by the bureau during the past 17 years, has proved its effectiveness in the past year in a number of incipient mine explosions, with the probable saving of a large number of lives. Where the method has been applied in accordance with the specifications of the bureau there has been no failure. On the other hand, explosion disasters have occurred in some mines where rock dusting has either not been done or has been done inadequately. The coal-mining industry is increasingly accepting rock dusting No other practical effective method has been found.

Ground movement and subsidence.—The gathering of data, especially in coal mining, on ground movement and subsidence from mining has continued, and at the experimental mine opportunity is offered for a special study owing to the withdrawal of pillars in an adjacent mine. Monuments were established and surveys made from time to time.

Occurrence of bumps in mines.—Bumps causing loss of life have occurred in the past year in coal mines in eastern Kentucky, where the overlying rocks are very strong and the surface is mountainous. Results have been studied and a report on the subject will be issued.

Oil-sand mining.—Some years ago bureau engineers studied the methods of obtaining oil from sands after wells from the surface in the locality stopped producing in mines at Pechelbronn, France, and Wietze, Germany. These mines were again visited by a bureau engineer; and the possibility of applying in the United States some of the methods used in these mines, and other methods proposed by American engineers, are being studied. A report on the subject will soon be submitted for publication.

EXPERIMENTAL MINE

Tests of rock-dust barriers.—The investigation of rock-dust barriers for stopping explosions in coal mines was practically completed during the year and a preliminary report was issued. Three types were approved for general use and four others for special use in certain locations. The industry is now provided with definite information on the use and limitations of these devices. Many State bituminous-mine inspectors were provided with blue prints of the barriers recommended by the bureau for general use.

Initiation of coal-dust explosions by gas explosions and electric arcs.—Tests were made to determine the smallest amount of gas which, on explosion, was capable of starting a general explosion of bituminous coal dust. The minimum quantity of dust that must be brought in contact with an electric arc to produce a general explosion was also determined. The sources of ignition were extremely small, but the disastrous results that might follow emphasize the necessity of thorough ventilation to prevent accumulation of gas and the need of proper rock dusting where electric arcs may occur simultaneously with the production of a cloud of inflammable dust.

Strength of mine stopings.—It has been shown that the strength of a concrete stoping depends largely on the restraint offered by the coal ribs in which it is recessed; quantitative values have been obtained under the test conditions. The work will permit drafting specifications for stopings installed in mines on public lands. The general knowledge and theory of restrained concrete beams will also be greatly advanced by the tests.

WORK OF THE ECONOMICS BRANCH

The economics branch collects and disseminates statistical data regarding the production, consumption, distribution, and storage of the numerous essential minerals. The results of these statistical and economic studies are widely used by the mineral industries in keeping in close touch with market trends and in the solution of business problems.

Accidents to the men employed in the mineral industries of the country result annually in approximately 2,800 deaths and more than 200,000 lost-time injuries. The economics branch makes statistical canvasses of the number and causes of accidents to persons employed in these industries. Information of this nature is essential to the study of effective means of accident prevention.

COAL DIVISION

The work of this division relates to the industrial and commercial economics of coal, as distinguished from technical problems. The field includes the uses of coal, reserves, prices, production, distribution, consumption, stocks, and marketing and involves the collection, analysis, and dissemination of statistical data on the coal and coke industries.

Statistical information on coal and coke is supplied through two principal channels: (1) Reports, issued weekly, monthly, and quarterly; and (2) annual reports which assemble detailed information in permanent form.

Regular features of the work of this division are a weekly coal report covering coal production; periodic surveys of current trends of consumption in principal industries and certain features of distribution; a monthly report covering general conditions in the coal industry; a monthly coke report; a monthly preliminary estimate of coal production; and a quarterly report of coal stocks.

In addition to current statistics and analyses the division publishes detailed annual data on coal, coke and by-products, and fuel briquets.

Results of special investigations published during the year were

as follows: Sources of bituminous coal used for railway fuel; the retail dealer as a distributor of coke; world energy supplies; studies in fuel efficiency; production of coal-tar crudes; production and distribution of hard coal outside of Pennsylvania; the economics of strip coal mining; screening equipment at bituminous coal mines; use of loading machines and conveyors, 1929; engineering advances in coal mining, 1913–1928; and the trend of coal demand.

Government fuel yards.—The Government fuel yards purchase and distribute coal, coke, oil, and wood to all Federal and District Government buildings and establishments (except the Washington Navy Yard) in the District of Columbia and to such institutions outside the District as can be economically reached. It maintains its own garage and fleet of 40 heavy-duty and light-delivery trucks; its coal-handling plant has a storage capacity of 13,000 tons of coal. During the fiscal year 1930 coal aggregating 252,542 gross tons was delivered to more than 500 points; of the total tonnage, 150,060 tons were delivered by trucks from the coal-handling plant and 102,482 tons shipped in railroad cars direct to plants having their own railroad sidings; the trucks traveled 167,088 miles, with an average round-trip haul of 5.36 miles. The sales value of the coal was $1,362,354; the sales value of wood, charcoal, and coke, and the charge for service work of hauling materials and of repairing motor vehicles for other branches of the Government was $26,108, making a total of $1,388,462. The Government fuel yards operate under a revolving fund, which is maintained by the sales of fuel and reimbursement for services.

DIVISION OF MINERAL STATISTICS

Statistics of mineral commodities.—This division collected statistics on all mineral commodities of commercial importance. These were published promptly in summarized form and later in more detail in the annual reports on Mineral Resources of the United States. The division also collected information on the mineral resources and mineral production of foreign countries.

Statistics of accidents, employment, and explosives.—The accident-statistics section canvassed all mines (except coal mines), quarries, coke ovens, and metallurgical plants in the United States, and prepared reports thereon covering accidents, men employed, methods of mining, days of operation, etc. Monthly and annual reports of fatal accidents in coal mines were prepared, based upon information obtained from State mine inspectors. The section also canvassed manufacturers of explosives and prepared monthly and annual reports on sales of explosives in the United States. A national safety competition was conducted among 311 large mines and quarries in 34 States.

PETROLEUM ECONOMICS DIVISION

The division assisted in the preparation of material for the current report of the Federal Oil Conservation Board; the specially appointed committee on petroleum economics; and other committees and agencies engaged in the study of economic problems related to conservation.

The enlarged production of natural gas, coupled with the continuing expansion of distribution facilities, has increased the public

interest in natural-gas developments. A critical analysis of available data on natural-gas supply and demand was prepared.

Regional studies of the Atlantic coast and Pacific coast areas were prepared. In its distribution studies the division has limited its activity mainly to fuel oil, but some progress in this direction has been made in connection with asphalt, motor fuel, and other petroleum products.

Economic Paper 9, Petroleum Coke: An Economic Survey of Its Production and Uses, published during the year, illustrates a new type of report which is being developed in response to a definite demand for accurate analyses of markets for special petroleum products. A study of the manufacture and use of liquefied petroleum gases, such as propane and butane, for domestic and industrial heating, was completed and the results issued in the form of a press statement. Plans are under way for a similar report on other petroleum by-products, such as the special asphalts, paraffin wax, and refinery-still gases.

Monthly and annual reports.—Monthly reports reflecting changes in the fundamental economic factors of the oil industry were prepared and distributed to approximately 2,800 concerns and individuals in the United States and 22 foreign countries. The broad interest in this statement is shown by the diversity of groups represented on the mailing list.

These reports form the basis for the correlation of supply with demand in the production of petroleum products; for the preparation of various reports of oil companies; and for the determination of policies by purchasing agents and other officials of oil-consuming industries. The monthly petroleum statement must be responsive to the technical developments in the oil industry and is consequently undergoing progressive development, with frequent changes and additions. Changes made during the year were undertaken after consultation with the bureau's advisory committee, appointed by the American Petroleum Institute in January, 1929, following the annual convention at which it was resolved formally that the bureau's work in petroleum economics "had been of great benefit to the industry by coordinating production and manufacturing operations to demand, with an important bearing on the conservation of a great natural resource."

Annual reports were published reviewing achievements in particular branches of the petroleum and allied industries. Whereas these reports previously were largely statistical, they now are being developed to include a complete economic discussion of the industries. Progress in this direction has been extended to include the annual reports on natural gas, natural gasoline, and carbon black, and will be further extended.

Foreign studies.—In addition to the annual preliminary estimate of crude-oil production in foreign countries, the division during the past year established the basis for other annual summaries regarding the production of petroleum products in countries other than the United States. At the suggestion of the American Petroleum Institute data were assembled on the production of natural gasoline in foreign countries, through the cooperation of consular offices and various companies engaged in foreign production. The assembly

of similar data on natural-gas production and the operation of petroleum refineries in foreign countries was commenced.

RARE METALS AND NONMETALS DIVISION

This division makes economic studies and disseminates information on all the metals and their ores, except 11 that are assigned to the common metals division, and all the known metallic minerals except sulphur (and pyrites) and fuels. It is responsible for the preparation of 25 or more chapters of Mineral Resources of the United States, and prepares information circulars, economic papers, and other publications on these and other commodities.

In many instances the division has brought buyers and sellers together. New uses are constantly being found for the so-called rare minerals, and the division attempts to translate technical developments into terms of commercial supply and demand. Market analyses, with particular reference to the distribution of sales by uses and by geographical areas, are made from time to time, and lists of buyers and potential buyers of the various mine products are compiled. To expand this service questionnaires were mailed during the fiscal year to 850 firms and the replies tabulated. The division also attempts to keep informed as to the mineral resources of the United States and maintains lists of producers of different minerals and of owners of deposits still unworked. These lists are incorporated in publications dealing with the particular commodities and thus receive wide circulation. In addition, 187 lists of possible buyers and 248 lists of producers were furnished last year in response to specific inquiries.

A report on the mica deposits of the United States and on the mica industry with particular reference to military procurement plans was completed.

Abstracts of the mining laws of foreign countries are being made with special reference to the needs of investors and the rights of Americans to own and operate mines abroad. The mining codes and ancillary legislation of 42 countries and self-governing territories have now been translated (where needed) and abstracts prepared. Most of these abstracts were published as informal circulars during the fiscal year. In addition, a correlated study of the mining laws of all Latin America was completed. A similar analysis of the mining laws of all countries, embodying a history of the development of mining legislation throughout the world, is in progress. The laws of some 25 additional political subdivisions are to be studied.

COMMON-METALS DIVISION

The common-metals division includes in its field the economic aspects of copper, lead, zinc, gold, silver, iron, chrome, manganese, nickel, aluminum, tin, pyrite, and sulphur. Manuscripts dealing with these metals are prepared for annual publication in Mineral Resources of the United States. In addition, special studies are made, some of which resulted in the following publications during the past year:

Economic papers: Summarized Data of Zinc Production, Summarized Data of Lead Production, Summarized Data of Gold Production, and Summarized Data of Silver production. A similar economic paper on tin production is nearly completed.

Papers published in journals include: The Flow of Lead Into World Trade, The International Flow of Copper, and The Sources of Gold Supply.

Information circulars include: World Reserves and Resources of Tin; one on sulphur, now in press; and a third on chromite. A canvass resulted in a circular on Consumption of Tin in the United States during 1928.

A paper on Gold Reserves of the United States, prepared jointly with the United States Geological Survey, was presented at the International Geological Congress at Pretoria, South Africa.

A paper on the sources of silver and other papers dealing with the sources of the common metals are in preparation. A chart showing production of common metals in the United States in 1928 was prepared.

The division continued the development of extensive data files on the commodities in its field, which records are used as a basis for service to industry and the public in replying to inquiries.

WORK OF THE HEALTH AND SAFETY BRANCH

HEALTH DIVISION

The activities of the health division have included experimental studies on carbon monoxide, refrigerants, warning agents for manufactured gas, toxic gases and vapors, analysis of mine gases, approval of gas masks, acid coal-mine drainage, causes of death among miners, medical organization and industrial hygiene, sanitary survey of mining camps, and incidence of silicosis and other diseases among miners.

Toxic gases and vapors.—The toxicity of the vapors of a number of comparatively new commercial organic chemicals which are synthesized from natural products or by-products and which promise to reach industrial importance, were determined as an aid in the development of markets and uses. These included ethylene dichloride, ethyl benzene, "Cellosolve" (monoethyl ether of ethylene glycol), ethylene oxide, vinyl chloride, "Dioxan," and methyl formate. A report on the toxicity of each of these compounds has been prepared for serial publication in the United States Public Health Reports.

The toxicity and health hazards involved in the use of aniline and dimethyl-aniline in a compound for removing the carbon from internal-combustion engines is under investigation.

Health hazards from dichloro-difluoro-methane.—A study of the toxicity of a new refrigerant known chemically as dichloro-difluoromethane revealed the compound to be practically nontoxic. This quality, together with the fact that it is noninflammable, increases the possibilities of its use beyond ordinary commercial and domestic refrigeration. It may have wide use in cooling the air for public buildings and perhaps for homes, and for cooling and conditioning

the air of deep mines where earth temperatures prevent economic operation or even prohibit the deeper operations necessary to follow the ore. In all these uses, contamination of the air with poisonous or explosive gases might be disastrous, and safety therefrom becomes a matter of more importance than in ordinary refrigeration. A report on the Toxicity of Dichloro-Difluoro-Methane: A New Refrigerant, has been issued as Report of Investigations 3013.

Odor intensity of commercial propane, butane, and pentane.—The odor intensities of commercial propane, butane, and pentane were determined to ascertain if leakage of the vapor of these compounds could be readily detected by the sense of smell, in advance of inflammable concentrations. These highly volatile products, which are extracted from natural gas and distributed under pressure in cylinders and tank cars, are finding increasingly wide usage as industrial and domestic fuel gas. A paper on Odor Intensity and Symptoms Produced by Commercial Propane, Butane, Pentane, Hexane, and Heptane Vapor, was published as Report of Investigations 2979.

Dust surveys in mines.—A second survey of the dust content of the air in a group of metal mines near Picher, Okla., was conducted for the purpose of ascertaining progress in reducing dust hazards. The use of recommended dust-prevention procedure, ventilation replacing the dusty air with dust-free air, and wet methods of mining were found to have effected a distinct reduction in the dust hazard.

Physiological effects of dust.—Physiological tests of samples of dust submitted for a determination of their suitability for rock dusting in coal mines were continued. The types of dust investigated were limestone, fly ash, and chimney dust, diatomaceous earth, and refractory dust. Limestone continues to appear to be the safest material for rock dusting.

Detecting natural-gas leakage.—Natural gas is practically odorless in explosive concentrations and therefore does not indicate dangerous leakage through the sense of smell. Leak surveys in which the natural gas distributed to two cities was impregnated with ethyl mercaptan vapor (a chemical which possesses a strong, disagreeable odor in high dilution with air) showed this means of detecting leakage to be far more efficient and to entail only a fraction of the cost of ordinary inspection methods. A report on the Use of Ethyl Mercaptan to Detect Leaks in Natural-Gas Distribution Systems was published as Report of Investigations 3007.

Carbon-monoxide asphyxia.—The study of the pathology and blood changes resulting from carbon-monoxide poisoning has been completed. The changes resulting from anoxemia, produced by the exclusion of oxygen from the blood by carbon monoxide, were found to be the same as those resulting from anoxemia produced directly by atmospheres deficient in oxygen, thus directly confirming the belief that carbon monoxide is a simple asphyxiant. The neuropathological findings explain the lack of response of many moribund cases of carbon-monoxide poisoning to present methods of treatment and suggest a rational method of treatment. Work relative to treatment has been started.

Benzol poisoning.—An extensive study of benzol poisoning has been started to obtain information that will help to reduce the health hazard in the use of benzol for solvent and general industrial pur-

poses and thereby increase the market for and value of this product. The contemplated study includes the mechanism of benzol poisoning and the fate of benzol in the body; the hypersusceptibility of certain persons to benzol; methods for detecting oncoming chronic poisoning; and the treatment of benzol poisoning.

Flame safety-lamp testing cabinet.—The characteristics and efficacy of the cabinet developed by the Bureau of Mines for testing flame safety lamps for dangerous defects in gauzes or improper assembling before taking them into the mine were investigated. The cabinet was found to afford a very rigorous lamp test. A report on a new flame-safety-lamp testing and demonstration apparatus has been prepared.

Carbon-monoxide detectors.—The cotton-covered ampoules filled with palladium chloride for detecting carbon monoxide were tested for sensitivity and reliability. It was found that the ampoules gave reliable indications of dangerous atmospheres when used at temperatures above 50° F., but that lower temperatures decreased the sensitivity and the indications were unreliable at freezing temperatures. A report on Tests of Ampoules Filled with Palladium Salt Solution for Detecting Carbon Monoxide was prepared.

Acid coal-mine drainage.—Investigations pertinent to the formation and disposal of acid coal-mine drainage were continued. It has been found that the acid content of the drainage increases with the pyrite content of the material with which it comes in contact, regardless of whether this material is coal, top or bottom rock, or gob. This suggests the possibility of reducing the quantity of acid by mining methods which will reduce contact of the water with acid-forming material. Reduction of the quantity of acid by excluding the air from exhausted mines or sections of mines, and thereby inhibiting the acid-forming reactions, has been shown beyond doubt. Worked-out and deserted mines of the drift type, if left unsealed, continue to produce acid water for many years after abandonment.

Health hazards from methyl chloride.—In a report issued during the fiscal year 1929 it was recommended that, because of lack of odor of harmful concentrations of methyl chloride, a substance should be added to give it sense-perceptive properties to furnish warning in event of accidental leakage. This recommendation has been seriously considered by the methyl-chloride industry and has led to the development of acrolein, a powerful eye and nose irritant. Investigations of the use of methyl chloride containing 1 per cent of acrolein in unit and multiple type refrigerating appliances have shown it to be effective in giving warning of leakage. An investigation of the effects of repeated daily exposure of eight hours to small amounts of methyl-chloride vapor, and an investigation of the danger of contamination of food by methyl chloride, were also completed. The following reports have been published: (1) Physiological Response Attending Exposures to Vapors of Methyl and Ethyl Bromides and Chlorides was published in the Proceedings of Congressus V. Internationalis Medicorum Pro Artificibus Calamitate Afflictis Aegrotisque, 1929; and (2) Observations on the Possibility of Methyl Chloride Poisoning by Ingestion with Food and Water, United States Public Health Reports, volume 45, No. 19, May 9, 1930.

Approval of gas masks.—To stimulate manufacturers of industrial gas masks to make appliances of good quality and to guide consumers in purchasing safe devices, examinations of manufacturers' products are made in accordance with a schedule which is thought to cover the minimum requirements of a safe device. If a particular mask fulfills these requirements, what is termed a "Bureau of Mines approval" is issued to the manufacturer and he is authorized to display the approvals as a mark of quality of his product. During the year, the M. S. A. acid gas and organic vapor mask was tested and approved. Approved gas masks are now available for practically every poisonous gas or vapor encountered in industry. Lists are issued periodically and are widely used by municipalities and industries for selecting equipment.

Physical examination of miners.—The work of the Bureau of Mines clinic, carried on at Picher, Okla., in cooperation with the Tri-State Zinc and Lead Ore Producers Association and the Metropolitan Life Insurance Co., was continued. During the fiscal year 7,469 men were examined, of which number 3,002 were original (first annual) examinations and 4,467 were reexaminations (second or third annual). In addition, 374 women and children were examined. A complete tabulation of the physical condition of those examined is being prepared for publication.

SAFETY DIVISION

The safety division operates 10 all-steel mine rescue cars in the United States and a mine rescue car in Alaska. In addition, 11 mine rescue stations have been established.

Each mine rescue car and station has a full complement of equipment and devices for use in case of mine fire or explosion, and each station has an up-to-date automobile truck. When a mine disaster occurs the bureau's forces are immediately placed at the disposal of the authorities, State, or company, to give such assistance as may be desired or available.

The activities of the safety division at ordinary times are directed largely to studies concerning safety and health in mining, prevention of mine explosions, explosibility of dust and gases, explosives and blasting, haulage, electricity, falls of persons or material, ventilation, dusts, high temperatures, timbering, lighting, machinery, etc.

During the fiscal year 112,572 full courses were given in mine rescue and first aid to those employed in mining and allied industries in 765 towns in 38 States and Alaska, by far the greatest number for any one year.

Since the bureau's establishment the safety forces have trained more than 480,000 persons in full first-aid and mine rescue courses, 281,828 or more than one-half of the grand total having been given the training during the past four years.

Much effort has been expended in the preparation of a special course of instruction in safety in coal mining. This course is now ready and will be used before January 1, 1931. Similar courses will be prepared for metal mining and for the petroleum industry. Scenarios for talking moving pictures on safety in mining are being prepared, and it is hoped to be able to start showing them during the fiscal year 1931.

During the last fiscal year the bureau safety men assisted actively at 157 first-aid and mine rescue meets, at which 2,516 teams involving 15,096 persons participated as principals. As a culmination of these local meets, there is annually held an international first-aid and mine-rescue meet which is sponsored and directed by the Bureau of Mines. At the international meet for 1929, held in Kansas City, Mo., 49 teams from 18 States competed.

The field men make underground mine examinations and reports on safety conditions which usually contain specific suggestions for improvement. During the year, 359 such reports were made by members of the division.

WORK OF ADMINISTRATIVE BRANCH

OFFICE ADMINISTRATION DIVISION

The office administration division is charged with the handling of matters of personnel, accounting, property, and general routine.

Personnel.—On June 30, 1930, there were 755 full-time employees on duty at the bureau, including 15 employees hired temporarily for job work. They were distributed and classified as shown in the following table:

	Classification and number of appointees				
	Professional	Subprofessional	C. A. F.	Custodial	Total
Washington	44	6	184	43	277
Pittsburgh	85	32	52	59	228
Field in general	113	48	52	37	250
Total	242	86	288	139	755

In addition to the foregoing full-time employees, the following persons were engaged on a when-actually-employed basis: Forty-one cooks, laborers, etc., employed on field agreements; 119 consulting engineers, chemists, etc.; and 100 other employees holding classified, unclassified, excepted, or temporary appointments on a part-time basis, making a total of 1,015 employees.

INFORMATION DIVISION

Owing to the lack of printing funds only part of the printed output of the bureau is issued through the Government Printing Office. In giving to the public the results of the bureau's investigative work, it is necessary to make use of the technical and trade press, publications of technical societies, and cooperative publications with educational institutions, State and municipal governments, and many other outside agencies. Since the reorganization and transfer of the bureau in 1925, resulting in added duties and increased activities, printing funds have not kept pace with the bureau's needs.

There were issued during the year 125 regular reports, 80 special reports of investigations, and 182 information circulars. During that period copies of the bureau's printed publications were distrib-

uted as follows: 28,480 bulletins, 28,721 miners' circulars, 43,109 technical papers, 2,700 annual reports, 5,840 economic papers, 111,247 separate chapters or bound volumes of Mineral Resources of the United States, and 249,326 miscellaneous documents (largely manuals of instruction in first-aid and mine-rescue methods) a total of 469,423 copies. Proceeds from sales by the Superintendent of Documents of bureau publications do not revert to the Department of Commerce.

Motion-picture production.—As a feature of its work in endeavoring to promote safety and efficiency in the mineral industries, the Bureau of Mines has prepared what is probably the largest collection of educational industrial motion-picture films in the world. These films are intended to explain the different steps in the production, treatment, and utilization of the essential mineral materials, and to illustrate safe methods of mining and preparing minerals. These films are produced through the cooperation of industrial concerns, who bear the entire cost of production.

On June 30, 1930, the bureau had 647 sets of films, aggregating 1,698,000 feet. The number of reels in circulation was 1,698. During the year the films were shown on 10,078 occasions before an estimated attendance of 1,712,858 persons. Distribution of the films is centralized at the bureau's Pittsburgh Experiment Station, and there are 14 subdistribution centers throughout the country. The films are loaned to schools, churches, clubs, civic and business organizations, scientific societies, miners' local unions, and others interested. No charge is made for use, but the exhibitor is asked to pay the cost of transportation. The following films were produced during the year: Refining the Crude, which tells the story of an oil refinery; Open and Shut, which tells the story of the construction and operation of the valve; and Silver: Heirlooms of To-morrow, which depicts the story of the silver industry.

The following films were completely revised, and additional copies were furnished for circulation: The Story of Sulphur, The Story of Asbestos, Fire-Clay Refractories, and The Story of a Storage Battery.

Very truly yours,

SCOTT TURNER,
Director, Bureau of Mines.

INTER-AMERICAN HIGH COMMISSION

INTER-AMERICAN HIGH COMMISSION,
Washington, July 1, 1930.

Hon. R. P. LAMONT,
Chairman United States Section,
Inter-American High Commission.

MY DEAR MR. CHAIRMAN: I have pleasure in submitting a brief statement of the work accomplished by the United States Section of the Inter-American High Commission during the fiscal year 1929–30.

The efforts of the section have been directed largely toward assistance in connection with inter-American conferences. The detailed agenda and reports for use at the Pan American Conference on Customs Procedure and Port Formalities were prepared or compiled by the section. Attendance by the Assistant Secretary at preliminary committee meetings, as well as the compilation of considerable documentary data, was necessary. In addition to the Assistant Secretary, several members of the staff were in attendance at this conference in November, 1929, in various capacities. Since then the section, in conjunction with the Department of Commerce and the United States Shipping Board, has initiated the assembling of data both here and in Latin America for use in the completion of certain studies in compliance with recommendations of the conference.

In preparation for the Pan American Conference on Agriculture, Forestry, and Animal Industry the section has done extensive statistical research, and completed comparative data regarding production, export and import of coffee, cocoa, rubber, and a few other commodities important in the foreign trade of the Latin American Republics. Cooperation along these lines is being continued to the conclusion of the conference in September, 1930. Some progress has been made on the standardization of commodities, in contemplation of the Third Pan American Standardization Conference, to be held at Habana either in 1931 or 1932. In anticipation of the Fourth Inter-American Commercial Conference, to be convened at Washington in 1931, the section has commenced the gathering of data and program suggestions from the member sections for submission to the Pan American Union. Research concerning conventions, resolutions, and recommendations of a commercial character of previous inter-American conferences was initiated.

Other conferences in which the United States section has participated during the past year were the meeting of the International Chamber of Commerce, at Amsterdam, attended by the Assistant Secretary, and the Inter-American Congress of Rectors, Deans, and Educators in General, at Habana, to which a member of the staff was detailed.

Notwithstanding the amount of cooperation afforded various agencies in conference work, studies and investigations under way on several subjects have progressed in varying degrees. A preliminary report comparing the legislation of the American Republics pertaining to commercial aviation is near completion. Another on the copyright laws of the Latin American Republics is being compiled. These two works have been carried as far as is possible with the material available, and their completion is dependent upon receipt of supplementary data from the other national sections.

In the matter of commercial arbitration several of the sections have submitted recommendations to the Central Executive Council for use in preparing a draft convention. A few of the member sections have appointed special committees to consider the advisability of a convention regarding ocean bills of lading. Initial steps toward the formulation of a draft convention on corporation laws have been taken by the section in cooperation with the Pan American Union.

Renewed efforts to secure action on these subjects will be made, and the analysis of other projects for consideration by the sections of the commission will be continued. Draft conventions or draft model laws dealing with negotiable instruments, conditional sales, copyrights, and patents will be prepared. The cooperation of the Latin American sections on all of the aforementioned matters, as well as any others delegated to this body by properly authorized agencies, will be appropriately sought.

Yours very truly,

WILLIAM L. COOPER, *Secretary.*

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